BLOOD PRESSURE SIMPLIFIED

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Foreword

THERE has been a constant and insistent demand for a handy reference book on Blood-Pressure.

This book has been prepared to satisfy that demand. In its preparation, in addition to much valuable original matter, quotations from recognized authorities only, have been used.

In the Bibliography, reference has been made to a wide variety of recognized authorities, covering in its entirety the subject matter of this book.

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PHYSIOLOGY OF ARTERIAL TENSION

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Definition—"Blood Pressure is the term used to indicate the pressure which the blood is exerting upon the walls of the vessel in which it is to be measured (lateral pressure) or upon the column of blood ahead of it in the direction in which it is flowing (end pressure)"—Hirschfelder. (1)

The arteries are a set of elastic tubes and the pressure of the blood in any one segment is brought about by the tendency of the inflow from the heart to remain in excess of the outflow through the capillaries.

THE HEART

"Though the left ventricle, dispensing its load under a high pressure into the aorta, is the master hand in maintaining the arterial blood-pressure, the height to which that pressure rises depends primarily on the resistance encountered in the

peripheral arterial system, and in the capillaries, and secondly on the response of the ventricle to overcome that resistance. Given a normal ventricle the arterial tonus largely determines the ventricular response, and the level of the arterial blood pressure—and this is the key-note of physiological and pathological variation of that pressure."—Oliver. (55)

HISTORY

The first blood-pressure determination of which we have definite record was made in 1855 by Vierordt when he ascertained the weight which would obliterate the pulse. His method, however, was very crude and gave us very little information. Marey was probably the originator of the first useful apparatus for determining blood-pressure—which was by the plethysmograph. He also made the first observations on the relation of the arterial volume change to the shape of the artery when the systolic wave is received, and thus arrived at a very fair estimate of the minimal pressure. Unfortunately, his work was little known and it remained for V. Basch in 1887 to really introduce blood-pressure determinations into clinical work. His instrument consisted of a small rubber bulb filled with water and connecting with a mercurial manometer. The bulb was pressed upon the radial artery until the pulse was obliterated. Riva-Rocci and Barnard and Hill introduced the use of the rubber bag surrounded by the non-elastic cuff of leather.

Though numerous methods for determining the minimal blood pressure had been devised,

notably those of Mosso, it remained for Masing in 1901 to suggest measuring the minimal pressure by the point at which the radial pulse became the largest.

At about that time Janeway estimated the minimal pressure at the point where the oscillation of the mercury column in the manometer became greatest.

Shortly after, Erlanger (3) developed his Recording Sphygmomanometer and elaborated the oscillatory method of determining blood-pressure.

The greatest advance, however, was in 1905, when the Russian, Korotkoff, brought out his auscultatory method. Since then blood-pressure technique has been considerably developed, largely through the simplicity and exactness of this method. Blood-pressure determinations of both maximal and minimal pressure are rapidly becoming a routine practice in the physical examination of every patient.

MECHANISM OF THE CIRCULATION

The force by which the blood is driven from the heart into the ramifications of the arterial tree is derived almost entirely from the contraction of the left ventricle. The ventricle is doing effective work during only a part of the period of its contraction, because the intraventricular pressure must not only equal, but must overcome the static column of blood in the aorta and the resistance of the aortic valve before the blood can be thrown into its channels.

As shown by Huerthle and Porter (2) the pressure in the ventricle remains tolerably constant

during the entire systole and a part of the energy is rendered potential in the arterial walls.

However, the intraventricular pressure falls, if the peripheral resistance is very low and rises if high. In a given arterial system the pressure of the pulse wave is greatest in the aorta.

The amount of diminution is determined by the friction due to the narrowing caliber and to the tone of the vessel walls in which it is flowing. Normally in the capillaries there is no pulsation, because the head of pressure in the arteries has been absorbed and the systolic prssure and diastolic pressure are almost equal (See Figs. 1 and 2.) The *amplitude* of the pulse wave is not a function of the pressure alone, but is also an indication of the resiliency of the arterial wall.

THREE FACTORS OF BLOOD PRESSURE

Since the moving of the circulation is brought about by a series of pulsations, due to the heart's contraction, it is evident that in a set of elastic tubes, such as the arteries, the pressure fluctuations must be considerable.

The highest and lowest points of these fluctuations are termed maximal and minimal pressures, corresponding to the contraction and rest intervals of the heart, respectively. The pressure generated by the ventricular contraction is a comparatively large force, acting over a short period of time (systole.) This energy is made potential in the arterial walls where it acts as a small amount of power over a comparatively long period of time. The difference between this high and low point of

Fig. 1

Diagram showing the left ventricle and arterial system during Diastole. The diastolic pressure is 80 mm. and represents a resistance borne by the aortic valves and arterial walls and directed contrary to cardiac force. The power furnished by the heart must be sufficient to equalize this resistance and enough in excess to render its work potential in the arterial wall.

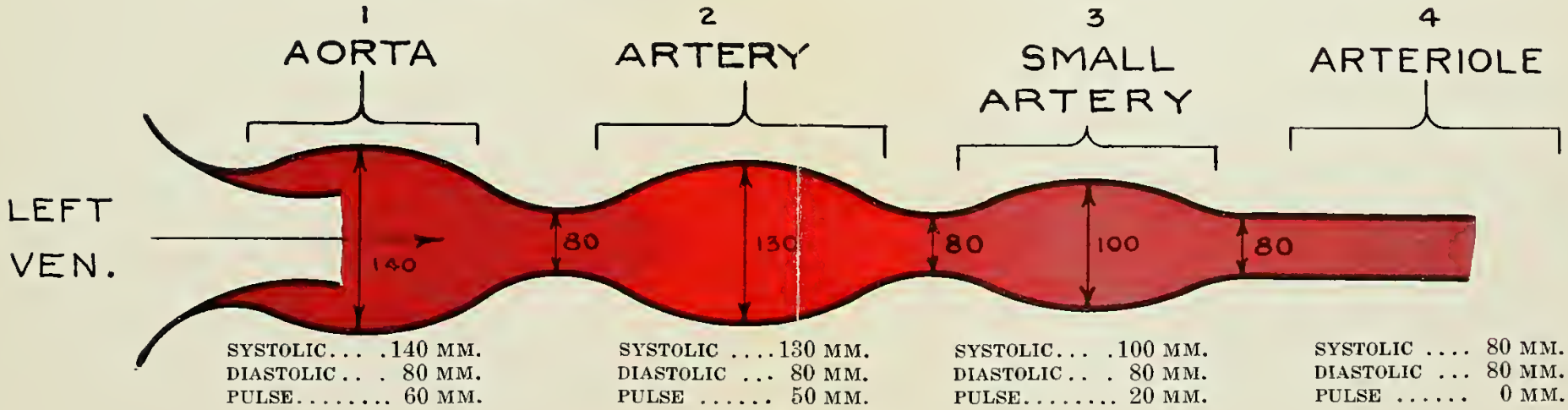


Fig. 2

Schematic Representation of the Blood-Pressure in the Arteries. Particularly intended to show the changes produced during the passage of a single systolic wave toward the periphery.

1—Illustrates the volume of blood thrown into the aorta from the left ventricle under high pressure (60 mm. pulse pressure).

2—Illustrates an absorption of pulse pressure from the aorta to a large artery, due to the peripheral resistance. Pulse pressure has been reduced by 10 mm. from previous level.

3—Illustrates a further absorption of pressure from a large artery to a small artery. The pulse pressure being reduced from 50 to 30 mm.

4—In the arterioles the head of pressure has been almost entirely absorbed, systolic and diastolic pressures being practically equal.

pressure represents the head of pressure which forces the blood onward toward the periphery. It is called the pulse pressure. A comprehensive knowledge of the blood-pressure, therefore, calls for a determination of these three factors—Systolic, Diastolic and Pulse Pressures.

RELATIVE VALUES OF THE THREE PRESSURES

(See Figs. 1 and 2.)

Systolic Pressure—Since during diastole the aortic valves are closed, the pressure of the blood in the arteries during this period represents a force directed contrary to cardiac force, and a resistance (peripheral resistance) that must be overcome by the next ventricular contraction. To efficiently maintain the circulation, the left ventricular contraction must furnish sufficient power to equal the peripheral resistance, with enough in addition to open the aortic valves and render its power potential in the arterial walls—Systolic Pressure represents total heart energy.

Diastolic Pressure—The diastolic pressure represents the entire load of pressure borne by the whole arterial system during systole. It is a resistance directed contrary to cardiac force, which must be equalized and overcome by the work of the heart. The diastolic pressure is but little affected by the transitory influences which so markedly affect the systolic and pulse pressures. Even comparatively slight changes, unless dependent on alterations in the pulse rate, are of much significance, as indications of circulatory condi-

tions (vaso-motor influences, and other causes of change in the peripheral resistance).

Pulse Pressure—The pulse pressure represents the efficient work of the heart and indicates the extent to which it overcomes the peripheral resistance. It is the excess of pressure, over and above that required to equalize the diastolic pressure, which opens the aortic valves, renders the work of the heart potential in the arterial walls, and forces the blood onward into the capillaries.

ACCEPTED METHODS OF DETERMINING BLOOD-PRESSURE

Three methods have come into general use for determining the maximal and minimal blood-pressure. These are:

1—Auscultatory—Korotkoff
2—Oscillatory
3—Palpatory

The first of these is eminently superior to the other two, and is the one in general use. The oscillatory method is used very little in the United States, but is more in use on the continent of Europe. *The auscultatory method gives readings of about 8 mm. greater than the palpatory method.*

A majority of the earlier statistics have been gained from the other methods and this should be taken into consideration in comparing two sets of statistics made at different periods of blood-pressure development. There are times, however, when the oscillatory and palpatory methods are of use and for this reason they will be described.

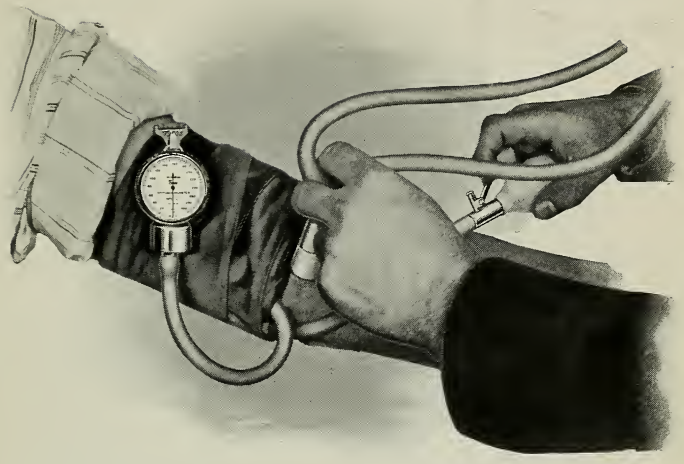


Fig. 3
Method of Auscultation

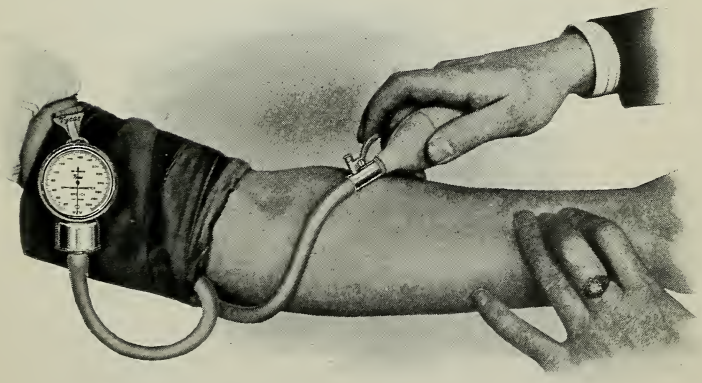


Fig. 4
Method of Palpation

GENERAL

There are certain general conditions which apply to all methods and which, though simple, are of considerable importance.

APPLICATION OF THE SLEEVE

It is highly important that nothing should be done to excite the patient, or to render him in any way apprehensive. The manner of talking to the patient and of applying the sleeve should be calm, and matter-of-fact. The attitude on the part of the physician, together with a minimum effort on the part of the patient, prior to the determination, will eliminate errors due to emotion, exercise, etc.

True blood-pressure readings are taken upon reducing the counter pressure in the arm band, from above the point where its pressure obliterates the lumen of the artery. To avoid subjecting the arm to excessive or unduly prolonged pressure, such as would occur were the inflation carried far beyond this point, the approximate readings of maximal and minimal pressures are roughly noted on inflating the sleeve and verified as the counter pressure is slowly reduced.

That part of the sleeve containing the rubber bag is placed well on the inside of the bare left arm above the elbow and the remainder of the sleeve wrapped around, precisely as a bandage would be applied, the last few inches tucked under the preceding fold. (See Figs. 3 and 4.) The question often arises as to the advisability of always having the patient bare the arm. Speaking generally we should advise it—in the interest of

scientific accuracy and for the welfare of the patient. However, occasions do occur where it is quite impossible to have the patient under ideal conditions, and in these cases, where the sleeve must be applied over a heavy undergarment, allowances must be made for it, and where the pressure is near the border line proper technique should be insisted upon.

For best results it is always necessary to have the patient under the same conditions as regards posture, time of day, meals, etc., in order that variations, due to physiological causes, may be eliminated.

The manometer is attached to one of the tubes leading from the compression sleeve, the inflating bulb, with release valve, is attached to the other tube.

The stethoscope is used to determine the various pressure phases, as indicated by the difference in the sound during restoration of the interrupted blood column, obtained by reducing the counter pressure in the sleeve.

Any of the many patterns of stethoscopes may be used. The one to which the physician has accustomed himself by use is usually to be preferred. The only requirement is that the resonator be of a size sufficiently small that its entire circumference adapts itself snugly to the arm and shuts out all adventitious sounds.

The resonator, or bell, should be placed over the brachial artery, well above the elbow and in the center of the space between the internal border of the biceps muscle and the internal condyle of the humerus. (See Fig. 3.)

SOUND PHENOMENA

Between the upper and lower limits of sound production marked variations in character and intensity are recognizable, and these show considerable differences in various circulatory conditions.

There are described five phases of sound during the lowering of the external pressure from above the obliteration point:

Dial to Aid Memory.

1—A Clear Sharp Sound or Click—the Index of Systolic Pressure.

2—A Murmur of Variable Duration replacing the above.

3—A Clear, Usually Loud and Snappy Sound, replacing the Murmur.

4—A Transformation (usually sudden, at other times more gradual) of the Clear, Loud Sound into a Dull One—The Index of Diastolic Pressure.

5—The Disappearance of all Sound.

(See Fig. 5.)

CAUSES OF THE SOUNDS:

There has been considerable discussion as to the exact causes of the sounds heard through the stethoscope in the Korotkoff method. The best work done on this subject is probably that of Erlanger (3) and he sums up as follows:

"The mechanism of sound production, in a word, is that the water-hammer moving through the artery in the compression chamber, under usual circumstances, strikes the stagnant blood in the uncompressed artery below and distends the artery there so as to give rise to sound. The wave started by this impact is transmitted down (and

up?) the artery with sufficient amplitude to produce sound locally as it proceeds, but only when the volume of blood coming through is sufficient and when the lower artery already is fairly full of blood, and therefore ordinarily only in the late second and third phases."

ESTIMATION OF SYSTOLIC PRESSURE

Criterion—The beginning of a clear, sharp tone on lowering the external pressure from above the obliteration point.

1—Place the stethoscope over the brachial artery about one half inch below the lower border of the sleeve (See Figs. 3 and 4.) No sound will be heard over the normal uncompressed artery.

2—On inflating the sleeve the sounds of the vibrating artery will be plainly heard, gradually growing fainter, as the external pressure is increased. Observe the point of disappearance of the sound and oscillations. It has occasionally been observed in individuals having hypertension that the second tone phase is often so faint as to be barely audible and the instance of the third phase may be mistaken for the systolic pressure. Therefore, as a precautionary measure, observe the point where hand oscillations and arterial pulsations cease; this insures that the lumen of the artery is entirely obliterated.

3—Gradually lower the external pressure until a clear tone is heard. *The point indicated by the hand on the dial, at the instant the sound is heard, marks the point of systolic pressure.*

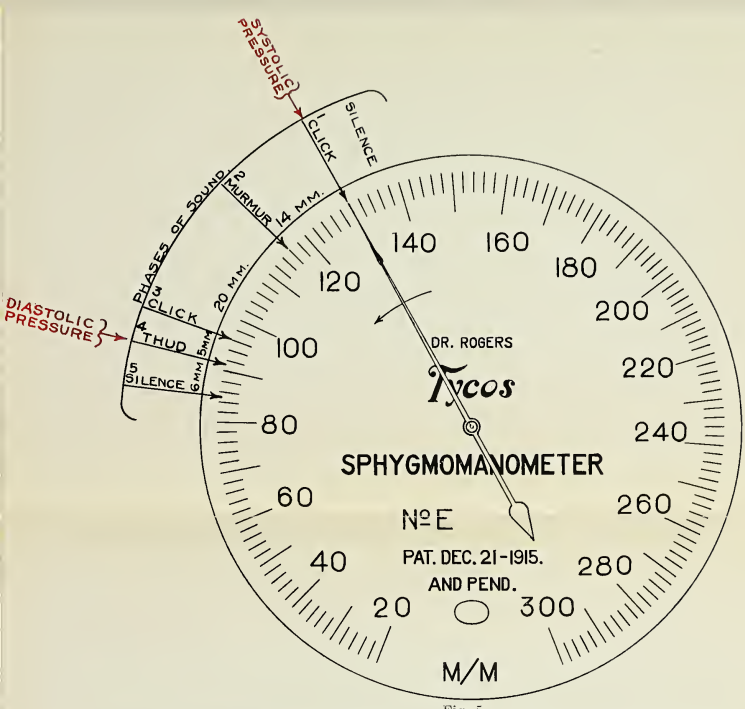


Fig. 5

Diagram to illustrate the characteristic change of tone and length of the various phases of sound heard through the stethoscope.

1—The first sound heard. A sharp click. The sign of systolic pressure. In the above diagram this phase covers 14 mm.

2—The second sound. A tone closely resembling a heart murmur. Has no particular significance. Is pictured here as lasting 20 mm.

3—The third sound. A click. Much like the first sound but generally louder and continues for about 5 mm. of scale reading.

4—The fourth sound. A dull thud or bump. The transition of the third to the fourth phase is the criterion of diastolic pressure. Of variable duration; about 6 mm.

IT IS OF COURSE UNDERSTOOD THAT THE *LENGTH* OF THE PHASES GIVEN ABOVE ARE TAKEN AS AN ILLUSTRATION ONLY AND SIMPLY REPRESENT A CONDITION *FREQUENTLY* FOUND IN THE NORMAL PERSON. THESE PHASE LENGTHS MAY CHANGE IN THE SAME INDIVIDUAL ON REPEATED EXAMINATIONS.

ESTIMATION OF DIASTOLIC PRESSURE

Criterion—the *lowest point* of the excursion of the hand on the dial, taken at the *instant of transition* of sound from a *clear loud tone* to an *appreciably dull tone.*

1—The Systolic pressure having been observed, the external pressure is slowly and intermittently released a few millimeters (2 to 6 mm.) at a time, so that the nature of the hand movements and the character of the sounds may be accurately noted.

2—*At the point where the third phase* (phase of clear and loud tone production) *is transformed into the fourth phase* (an appreciably dull tone) the *diastolic reading* is taken at the *lowest point reached by the excursion of the hand on the dial.*

Though the method of Korotkoff has generally been considered an auscultatory method, it is really a combination of the oscillatory and auscultatory methods, because the true point of diastolic pressure is the lowest point of arterial pressure fluctuation. This is accurately indicated by the low point of the hand oscillation.

VALUABLE INFORMATION TO BE GAINED FROM OBSERVATION OF HAND MOVEMEMENTS

Valuable information may be derived concerning the general condition of the arterial system by noting the variations of amplitude, rate and rhythm of the pulse, as shown by the hand movements of the sphygmomanometer.

Other things being equal, a small or a constricted artery, or an artery in which there has

been considerable connective tissue change, usually gives a pulsation of small amplitude, while a large or a relaxed artery, or one of great resiliency will give an excursion of large amplitude.

ALTERNATION OF THE PULSE

Alternation of the pulse is a sign of grave prognostic import and indicates a badly damaged myocardium. According to Herrick (4) the sphygmomanometer may be used to great advantage in diagnosing the condition. By raising the external pressure to a point where only half the beats come through, their alternation is easily discernible. (See Chapter 10).

Auricular Fibrillation—The marked changes in the rhythm and amplitude of the pulse which occurs in this condition are clearly indicated by the movements of the needle. Methods of determining blood-pressure under such conditions are considered under Chapter 10.

PALPATORY METHOD OF ESTIMATING SYSTOLIC PRESSURE

Criterion—The return of the pulse to the palpating fingers on lowering the external pressure from above the obliteration point.

1—Palpate the artery, care being taken that the pulse is not cut off by undue pressure. (See Fig. 4).

2—Inflate the sleeve, observing the amount of pressure required to totally extinguish the pulse. Advance the pressure about 20 mm. above this point.

3—Gradually lower the external pressure until the pulse reappears. *The point indicated by the hand on the dial, at the instant the pulse returns, marks the point of systolic pressure.*

OSCILLATORY METHOD OF ESTIMATING DIASTOLIC PRESSURE

Criterion—the lowest reading of the oscillating hand taken at the point of *abrupt diminution* just after the *greatest excursion* of the hand on the dial.

1—The systolic pressure having been observed, slowly lower the external pressure a few millimeters (2 to 6 mm.) at a time, so that the oscillations of the hand may be carefully noted.

2—The lowest reading of the excursion of the hand taken at the point of abrupt diminution just *AFTER* the greatest oscillations have occurred marks the point of diastolic pressure.

NOTE: The development of oscillation varies greatly and is influenced by so many factors that the method is not recommended.

PULSE PRESSURE

The pulse pressure is the difference between the systolic and diastolic pressures. For example:

Systolic Pressure ....120 mm.
Diastolic Pressure .... 80 mm.

Pulse Pressure ..... 40 mm.

MEAN PRESSURE

Mean pressure is of little practical importance and is mentioned here simply for completeness. There are several ways of computing it, the most common being the method of dividing the sum of the systolic and diastolic pressures by two.

Warfield (16) puts forth that the mean pressure follows the diastolic more closely than the systolic.

Dawson (5) estimates the mean pressure by adding one third of the pulse pressure to the diastolic.

WHEN TO TAKE BLOOD-PRESSURE

Blood-pressure should be estimated in the first examination of every patient, in every examination of the cardiovascular system, occasional examinations for the purpose of establishing progress in cardio-vascular-renal disease, and in every examination for the certification of health, as applications for life insurance, police, firemen and the examination of athletes.

HEART LOAD RATIO

Stone (6) has given a figure representing the heart load ratio in millimeters of mercury, obtained by dividing the pulse pressure by the diastolic pressure thus: $\frac{PP}{DP}$. According to him, the pressure necessary to equal diastolic pressure is of no use to the circulation, but the amount exerted in excess of this figure is the real measure of the circulatory efficiency. This he gives as 50%, as a normal heart load ratio; that is, a pulse pressure of one-half the diastolic pressure. For example: A diastolic pressure of 80 with a systolic pressure of 120 will give a pulse pressure of 40, obtained by subtracting the smaller from the greater pressure. The pulse pressure divided by the diastolic pressure has a fraction of one-half, or 50%.*

* For further consideration of the above see under Diagnosis of Hyper-tension.

PERIPHERAL AND SPLANCHNIC FACTORS

Richter (7) emphasizes the value of Poiseuille's Law, which is that the flow of blood is increased by the dilatation of a small artery at the ratio of the fourth power of the radius of a vessel, while pressure itself increases in arithmetical proportion.

Turning now to the central area of the vascular system, we find the great splanchnic vessels of blood tanks of the abdomen, which are capable in themselves of containing practically the entire blood volume of the body. It is obvious that they must be in a state of considerable tonus all the time, in order to maintain the pressure in the arteries.

A dilatation of these large receptacles, from whatever cause, constitutes one of the factors generally found in shock.

VISCOSITY

"A word should perhaps be inserted here in regard to the viscosity of the blood. This property of the blood is very important in influencing the work of the heart, due to the friction co-efficient being largely dependent on this property. Viscosity of the blood depends almost entirely on the viscosity of the red corpuscles"—Hirschfelder (1).

It would seem also that the amount of oxygen carried by the blood has the effect of decreasing the viscosity.

VENOUS PRESSURE

Until quite recently it has been generally assumed that venous blood-pressure passively

responds to changes in the peripheral resistance of the circulation and that it rises and falls inversely to the pressure in the arteries. There is now a growing belief, supported in part by experiments on both animal and man, that the pressure in the venous system may be dominated by a special nervous mechanism. We cannot review the entire story of this chapter of the physiology of the circulation, which is still far from being presented in its final form. One apparent early obstacle to the hypothesis of a "venomotor" nervous mechanism has been in part met by the well established demonstration that the venous system is actually supplied with motor nerves.

In distinction from the assumption that under normal conditions of life the peripheral resistance alone controls the magnitude of the venous pressure, Henderson (8) has put forth the hypothesis that there is a venopressor mechanism which functions to maintain an optimum feeding pressure to the heart. This forms a part of his theory respecting the maintenance of the volume output of the heart. The newest researches of Hooker (9) at Johns Hopkins Medical School on the venous blood-pressure in man, are in harmony with the existence of the hypothetic venomotor mechanism.

According to Hooker (9), the venous pressure in man exhibits a distinct diurnal rhythm, rising throughout the day from 10 cm. to 20 cm. of water and falling again during the night. The normal venous pressure varies considerably, averaging in the day time and under usual conditions about

15 cm. of water; in sleep, at night, it may fall to 7 or 8 cm.

NORMAL BLOOD-PRESSURE

The normal systolic pressure in adults ranges from 105 to 145 mm. In children over two years of age from 85 to 110 mm. In females the pressure is about 10 mm. less than in males.

The normal diastolic pressure ranges from 25 to 50 mm. below the systolic pressure.

A normal pulse pressure ranges from 25 to 50 mm.

A systolic pressure below 100, or above 150, and a pulse pressure below 25 or above 50 mm. may be regarded as abnormal. A diastolic pressure of 105 or over is almost always pathological.

INFANTS AND CHILDREN

But very little work has been done on blood-pressure in infancy and childhood. It is difficult to make blood-pressure determinations on children, because of the emotional factors. Until recently no suitable apparatus has been on the market for these blood-pressure determinations in pediatric work. At the present time, however, there is a special form of sleeve available which is very satisfactory. In very young infants the arm is entirely too small for the ordinary cuff and it should be applied on the thigh.

Melvin and Murrray (10) set a normal of systolic 108 and diastolic 72, for the ages of 4 to 14 inclusive.

Before birth blood-pressure is higher in the pulmonic than in the systemic circulation. The

expansion of the lungs which occurs in normal infants immediately after birth promptly lowers pulmonary blood-pressure.

At birth systolic pressure is said to range between 35 and 55 mm., waking and suckling causes a rise of about 15 mm.

Preceding the onset of puberty there is a tendency toward a fall of pressure, during pubescence there is a period of increased pressure, which in turn is followed by a slight decrease after puberty has been established.

POSTURE

The question of the relation of posture to blood-pressure has received a great deal of attention recently, and as yet, after careful searching of literature, no definite statements may be made.

It is contended by some (11) that blood-pressure is lower on the patient lying down, while others (12) say that it is the same and still others (13) say there is an increase in the systolic pressure and a decrease in the diastolic upon reclining, which would seem to be of considerable importance in this connection. However, the effort exercised by the individual in maintaining the given position—that is: whether the position is active or passive, is the important factor. In any case the posture should be the same in a series of readings, to insure correct results.

Rolleston (12) mentioned a "Hypo-tension of Effort" existing in his convalescent cases, in which the pressure on standing was the same or slightly lower than in a recumbent position.

ATMOSPHERIC INFLUENCES

Humidity—Recent research has shown that atmospheric humidity plays a tremendous part in physiological existence. This is nowhere more plainly shown than in its effect on blood-pressure. Comparatively slight increases in relative humidity, noticeably with a high dry-bulb temperature, causes very low systolic and diastolic readings.

In a series of cases recently under our observation, with a humidity of 80%, and a dry bulb temperature of 90° F. a number of systolic blood-pressures of 90 and 110 were found. Within 48 hours, with a subsequent drop in temperature and a lowering of humidity, these pressures assumed the normal of near 120 and 130. The diastolic of these cases was also perceptibly lower.

BAROMETRIC PRESSURES

It has been averred by some investigators Dexter (14) that barometric pressure influences our general lives to a marked extent, both physiologicaly and mentally, and no doubt the blood-pressure takes part in these responses to external conditions.

The optimum of the vital functions of the human economy in all likelihood indicates some certain complex of other agencies, of which we are now only slightly cognizant; as for instance: the ultra-violet ray, light rays in general and radio active emanations, but our knowledge is so very slight that much research will be required before we can commit ourselves to positive statements.

CHAPTER II

HYPER-TENSION

Definition—Transitory Rises Due to Physiological Causes—A Consideration of Hyper-tension in Relation to the Diseases in Which It Is a Factor.

Definition.—Arterial hyper-tension is a term applied to the condition in which the tension of the blood in the arteries is above a certain point, closely associated with a normal functioning of the body. This normal point, or optimum of existence, is subject to variations during the life of the individual, being higher at old age and lower in youth, but still representing a normal condition, if senility is admitted as normal. It is moreover probably true that each individual is largely a law unto himself and that several successive blood-pressure estimates are necessary to establish this point in a given case.

TRANSITORY RISES DUE TO PHYSIOLOGICAL CAUSES

It may be stated in the light of our present knowledge, that hyper-tension existing over a period of some duration (days) is abnormal and pathological. It follows therefrom that physiological rises are only transitory and the tendency to persist is a good criterion as to the normality of an existing hyper-tension.

The functions of most organs are discontinuous and the blood supply to any organ depends on its state of activity. It follows from this that there

are continual changes in the pressures in the arterial tree, to satisfy the calls of the various organs at different times. For instance: after meals there is a decided rise, due to the process of digestion, which is accompanied by dilated vessels in the stomach and accessory glands. Pressure must be raised to keep up the normal rate of flow of the blood that elimination, as well as nutrition, may be carried on properly.

The *EMOTIONAL STATES* such as anger, fear, etc., cause a temporary hyper-tension.

As was shown previously (Chapter 1) a reclining posture, according to some authorities, raises blood-pressure.

A dry, cold atmosphere may make a difference of 3 to 10 mm., blood-pressures being always higher in atmospheres of low humidity.

Pressure is lowest during early morning hours when one is asleep.

In women, menstruation causes a rise in blood-pressure just before the onset of the period.

Defecation—Blood-pressure is raised during the process of defecation, due largely to the compression of the splanchnic blood vessels by the diaphragm and accessory abdominal muscles.

A CONSIDERATION OF HYPER-TENSION IN RELATION TO THE DISEASES IN WHICH IT IS A FACTOR

Heart Load Ratio: (See Stone's formula, Page 14).

On the basis of his heart load ratio figures, Stone classifies his hyper-tension cases into two groups—a Cerebral and a Cardiac group.

The characteristics of the two groups are:

First—In the Cerebral Group. We have a high diastolic pressure and a heart load ratio within normal limit. Under this group are found many patients with high diastolic pressure and cerebral symptoms, the primary phases of which have for many years been placed under the heading of Uremia.

Second—The Cardiac Group. The distinctive feature of this group is the low diastolic pressure as compared with the Cerebral group. In the Cardiac hyper-tension group the main subjective symptoms were fatigue on exertion and dyspnea, anginoid pains in chest, edema of extremities and palpitation. The death occurs most frequently with the symptoms of a gradually failing heart muscle.

Arteriosclerosis—Arteriosclerosis may be defined as a chronic disease of the arteries and arteriols, characterized anatomically by increase or decrease in the thickness in the walls of the blood vessels, the initial lesion being the weakening of the middle layer, caused by various toxic or mechanical agencies. This weakness immediately leads to secondary effects, which include the hypertrophy or atrophy of the inner layer and not infrequently hypertrophy of the outer layer—connective tissue formation and calcification in the vessels and the formation of minute aneurysms along them.

"Veins are sometimes affected in the general morbid process."—Warfield (16).

Etiology—There is no doubt that *heredity* plays a great part in the etiology of arteriosclerosis.

Especially does *SYPHILIS* in the parents leave its stigma in the succeeding generations in the shape of poor arterial tissue which is thrown into earlier degeneration. *No age* is exempt from the lesions of arteriosclerosis. Fisk (15) maintains that proper diagnostic technique would show lesions quite constantly in persons of very early age. However, it is most generally seen in persons past middle life. It may occur in infants. *Cerebral Hemorrhage* in a child of two years has been seen. In these cases there is generally no question as to the existence of Lues. Hyper-tension, as a too oft repeated natural process of compensation, may cause arterial thickening. According to Warfield, (16) hyper-tension *per se* holds first place as a cause of true arteriosclerosis.

Occupation and Manner of Living.—Occupation entailing prolonged exercise and exposure or psychic activity, accompanied by worry will cause hyper-tension. Thickened arteries are simply a visible factor in the response of the human economy to the unnatural demands made upon it by the strenuousness of our modern life. The strain of business, and to an extent the strain of certain recreation on business men, and the policy of "speeding up" applied to the laboring classes, has, in both alike, produced its own pathology. *SEXUAL CONTINENCE* is also sometimes blamed. *ALCOHOL* and *DRUG INTOXICATIONS* are no doubt potent factors in the etiology of arteriosclerosis. *OVER EATING:* There can be no doubt but that the constant overloading of the stomach with rich or difficultly digestible food is responsible for a large number of cases of arterio-

sclerosis. Everyone must have noted the increase in force and volume of the heart beat after the ingestion of a large meal. The constant repetition of such processes can conceivably lead to damage to the vessel walls through hyper-tension. *RENAL DISEASE* is a certain producer of hyper-tension. It is very probable that in any case of hyper-arterial-tension, existing for some time, renal disease is present, even though there may be no signs directly referring to the kidneys.

Diagnosis.—The blood-pressure in arteriosclerosis is generally high. On the other hand Fisk (15) states that "low blood-pressure was frequently found with marked thickening and a surprisingly slight degree of thickening in cases with fairly high pressure (180 and 190), and absolutely no thickening in other cases of fairly high pressure, raising a question as to whether the part played by mechanical factors in causing thickening has not been over estimated and the toxic and bacterial factors underestimated." However, the highest readings are always accompanied by renal involvement. There is usually more or less cardiac hypertrophy, which manifests itself by the usual signs.

Very little reliance is to be placed on the presence of palpable arteries, as there may be considerable sclerosis at some portions of the arterial tree and not at others.

Ophthalmoscope.—An ophthalmoscopic examination is never to be forgotten. According to Warfield (16) "It would not exaggerate too much to say that the examination of the eye grounds with the ophthalmoscope is a most important aid in the

early diagnosis of arteriosclerosis. Long before there are any subjective symptoms, changes may be seen in the blood vessels of the retina, which, while not always diagnostic, at least call attention to a beginning chronic disease. As I become more proficient in the use of the ophthalmoscope, I am impressed with the importance of the ocular signs of arterial disease. I would urge practitioners to familiarize themselves with this instrument."

Symptoms.—"Symptoms usually complained of are dependent on the part involved. With renal involvement, there is headache, quite frequent and severe. Patient also complains of pain or pains all over the body, dizziness and dyspnea." Warfield (16).

The onset of arteriosclerosis is generally extremely insidious. L. Renon (17) mentioned continuous morning headaches as one of the early symptoms, especially on thinking, the "Painful Thinking," of Josue.

Numbness and tingling of the hands and feet, arms and legs are also complained of, also occasional epistaxis. Frequently there may be some slight edema of the ankles. Dyspeptic symptoms are common.

Visceral Sclerosis—Visceral Sclerosis is nearly always accompanied by pain in the abdomen, in some cases there is vomiting, backache, tenderness over the epigastrium, and there may be psychic disturbances.

Prognosis—An accurate prognosis in arteriosclerosis is no easy matter. The most that may be said is that arteriosclerosis is always a serious disease from the time its symptoms make themselves

known. The gravity depends altogether on the seat of the greatest arterial changes. It is necessarily greater when the seat is in the brain than when it is in the arms or legs. Give always a guarded prognosis—Warfield. (16).

Nephritis—Renal Disease (quoting again from Warfield (16) Chronic Disease of the Kidneys is one of the most certain producers of hyper arterial tension, in fact, some maintain that high tension even without demonstrable kidney lesions, as revealed by careful urine examinations, is a valuable sign pointing to chronic nephritis. Just what causes the increase in blood-pressure, sometimes to over 270 mm. of hg., is not definitely known. It seems most probable that it is some poison elaborated by the diseased kidneys and absorbed into the general circulation. There it acts primarily on the musculature of the arteriols, causing tonic contraction and an increase of work on the part of the heart to force the blood through narrowed channels. One fact is certain: we see patients with blood-pressures much over 200 mm. of hg., as these cases clear up the pressure falls and should they seemingly recover, the recovery is accompanied with a marked decrease in blood pressure, finally reaching the normal for the individual. Moreover, in the course of severe acute or subacute nephritis, hyper-tension is associated with headache, partial or total blindness and drowsiness. When the pressure is reduced, all these symptoms disappear.

There is usually the chronically shrunken and scarred kidney, known pathologically as the "arteriosclerotic kidney." It is possible that there

are two groups of cases which we may designate: primary and secondary. In the primary group the kidney disease antedates the sclerosis of the arteries, and the sclerosis is most probably dependent on the constant high tension. We know that prolonged hyper-tension will produce severe forms of arteriosclerosis. The arterial disease in this group is caused by the renal disease.

In the second group the kidney changes are apparently due to the general arteriosclerosis which, affecting the kidney vessels, causes changes leading to atrophy and subsequent fibrous tissue growth in scattered areas. These cases are not necessarily associated with hyper-tension; on the contrary there is more apt to be hypo-tension. Where the first group occurs for the most part in young and active middle aged people, the second group is the result of involuntary processes which accompany advanced age.

We have learned that, no matter how careful the analysis of the urine may be, we cannot be sure of the pathological state of the kidney which secretes the urine. Too often so called normal urine, which contains considerable albumen and many casts, may be secreted by a kidney almost perfectly healthy, the lesions being only of a transient and trivial nature—Warfield (16).

These cases show us a high diastolic and systolic pressure. The high diastolic usually obtaining in the later stages of the disease. A point in the therapeutic diagnosis mentioned by Elliott (18) is the very unsatisfactory response of these conditions to treatment. The mortality is high, the causes of death being heart failure, uremia and

apoplexy, in their order of frequency. The highest average of both systolic and diastolic pressures known occurs in these cases.

Uremia—Uremia is always accompanied with a very high blood-pressure; so high indeed as to be of great diagnostic import. The cause of the constant rise is not definitely known, but is probably due to circulatory toxins, as defective elimination is one of the main factors of the disease.

Auto Intoxication—Auto Intoxication is usually accompanied with a high systolic pressure, due to the vasoconstriction and spasms of the arteries before actual organic change has taken place. In this condition some circulating pressor substance is present in the blood generated in the intestinal tract by bacterial action. One of these pressor substances is supposed to be Hydroxyphenoethylamine—a split product from Tyrosin.

There may be *hypo-tension* also, as Barger and Dale (19) have succeeded in isolating a toxic depressor base from the intestinal mucosa.

Angina Pectoris—The chief factor in the causation of this disease is coronary sclerosis, and the blood pressure is usually affected according to the extent of the arterial change. During the attacks the pressure may rise or fall and in the intervals there may or may not be an elevation of the pressure. The recognition and treatment of those cases accompanied by high pressure is often attended by considerable relief and may entirely prevent the attacks.

Valvular Lesions—With the exception of aortic insufficiency, compensated valvular lesions of the heart present but little variation from the normal.

The principal value of blood pressure examinations in these diseases is to establish the condition of the heart muscle, and as a guide to the prognosis and general management. The information gained indicated the efficiency of the treatment, the proper dosage and the interval of administration.

Aortic Regurgitation—Blood-pressure examinations in aortic insufficiency show a constantly high pulse pressure, which is almost pathognomonic, and by which a diagnosis is often first made. The high pulse pressure may be due to a fall of the diastolic pressure (Sys. 120. Dias. 50 Pulse Pressure 70) as is most common in the endocarditic group, or to a considerable rise in the systolic pressure, with relatively little change in the diastolic (Sys. 170 Dias. 90 Pulse Pressure 80) as is usual in the arteriosclerotic group.

Asphyxia—If an animal is deprived of oxygen, phenomena ensues which produces a picture which we call asphyxia.

If the deprivation be sudden, as in tying off the trachea, death occurs inside of five minutes and is preceded by convulsions. Where suffocation is more gradual, as in a closed chamber, convulsions do not appear and life is more prolonged.

In addition to the motor and respiratory manifestations with dyspnea, however, there is a striking effect upon the vaso-motor and vagus centers.

In the first stage, during which the respiratory center is stimulated and breathing is rapid and deep, the vasomotor center in the medulla is also thrown into action and a marked rise in blood-pressure occurs, which is accompanied by increas-

ing slowness of the pulse and simultaneous activity of the vagus center.

In the latter stages, as the irritability of the respiratory center becomes exhausted, the other bulbar centers likewise fall. Then the spinal vasomotor centers begin to act and the blood-pressure is maintained at a high level, with increasing heart rate, and spasmodic ineffectual respiratory action, only to fail during the last seconds of life, when the spinal centers have become utterly exhausted.

An extreme rise of blood-pressure caused by asphyxia, and in a lesser degree by slighter grades of deficient oxygenation of the blood, is of distinct clinical import, as in the study of arterial pressure in cardiac and lung conditions, laryngeal diphtheria, etc.

Alcohol—Alcohol exercises marked pressor effect on blood-pressure and acts as a circulating poison.

Brain Tumor, Cerebral Hemorrhage, Meningitis, Increased Intracranial Tension, Apoplexy, Cerebral Thrombosis, Fracture of the Skull, Intracranial Hemorrhage, Rapid Growing Brain Tumor and some cases of Uremia—in these conditions undoubtedly will be found the highest blood-pressures recorded in disease.

Hirschfelder (1) says "Maximal blood-pressure may rise to 300 or 400 millimeters, minimal to 160 or over, pulse rate low, 60 or under."

Cushing has shown that when the intracranial tension rises above the blood-pressure, anemia of the vasomotor center brings about a tremendous vasocontraction and action of the augmentor

fibres in increasing the strength of the heart beat. The blood-pressure rises in successive stages (Traube-Hering Waves) until the mean pressure exceeds the intracranial pressure. The rise of blood pressure expresses the need of the brain for blood, to counteract the vasoconstriction with nitrites or other vasodilators, or venesection only increases the task of the heart.—Hirschfelder. (1)

CHAPTER III

HYPO-TENSION

Definition—Transitory Lowerings Due to Physiologic Causes—A Consideration of Hypo-tension in Relation to the Diseases in Which It is a Factor—Summary.

Definition—By hypo-arterial tension is meant a condition in which the pressure of the blood in the arteries is below a point which is generally associated with a normal or optimum function of the economy. (See Normal Blood-Pressure Page 17).

TRANSITORY LOWERINGS DUE TO PHYSIOLOGIC CAUSES

The blood-pressure does not physiologically so often fall below the normal limit, as has been supposed.

Micturition—Micturition reduces the blood-pressure temporarily.

Exercise.—After rather prolonged exercise in a very well trained man, there is a slight fall of pressure.

Hunger—Hunger in all probability lowers blood-pressure.

Atmospheric Influences—Miller, J. A. (20)—As was mentioned in Chapter 1, blood-pressure is, to a certain extent, affected by humidity. The higher the humidity, the lower the blood-pressure. This should always be thought of when there is a wide variation between readings of different days. In fact, the practice of checking a blood-pressure reading with a hygrometer reading is one which

will explain a great many otherwise puzzling problems and lead to much greater accuracy in statistics. Staehelin (21) finds that a fall of barometer pressure causes temporary hypo-tension.

A CONSIDERATION OF HYPO-TENSION IN RELATION TO THE DISEASES IN WHICH IT IS A FACTOR

SUMMARY

General—Bishop (22) would have us believe that a so-called essential hypo-tension exists quite frequently and that this fact has been very much underestimated. Individuals of apparent health, but who tire easily and are subject to every passing infection, have a splanchnoptosis, complain of headache, etc., are many times causes of hypotension. One of the common symptoms of low blood-pressure is headache, which is always relieved when the blood-pressure is raised.

Tuberculosis — Pulmonary tuberculosis presents the classic picture, clinically, of hypoarterial tension.

Very often patients in whom no evidence of tuberculosis is found show their predisposition to this disease by continual low blood-pressure. This statement is so well borne out, that given a patient living in unhygenic surroundings a persistently low blood-pressure, should always put us on our guard. Once the lung has become the site of a tubercular focus the blood-pressure drops as the ravages of the disease advance and by the same token a rise in blood-pressure is of favorable import.

The systolic pressure is usually affected more than the diastolic and the resultant narrowing of the pulse pressure range is a bad indication. As to the cause, nothing definite is known. "The causes of low blood-pressure in tubercular hypo-tension are probably primarily a toxic action on the vaso-motor center of the medulla, allowing of a vaso paresis, or stimulating an active vaso-dilatation, and secondarily, progressive cardiac atrophy, or degeneration"—Emmerson (23).

Typhoid Fever—Typhoid Fever alone in almost every case is accompanied by a low blood-pressure, as are in fact almost all of the infectious diseases.

From the end of the first week of the disease the pressure begins to fall and will generally continue to fall until about the end of the fourth week; even in some cases going as low as 90 mm. systolic pressure with a high diastolic. After the fourth week, in a favorably progressing case, the pressure will begin to rise gradually. A decided marked rise in pressure always precedes a perforation—Crile (24). By keeping close blood-pressure records one can differentiate between the collapse from hemorrhage and intestinal perforations. Where peritonitis exists, the fall in pressure is extreme and the condition fraught with danger.

Rolleston's (12) series seems to show a persistent hypo-tension for many weeks after convalescence is well established.

Pneumonia—The record is low blood-pressure in the first stages of the disease; there may be a transitory hyper-tension but, as in nearly all acute infectious diseases, there is a steady decline. A rapid drop should lead us to look for cardiac dila-

tation. The severity of the disease is, to a certain extent, a function of the blood-pressure, varying directly. Shortly after the crisis blood-pressure will rise.

In this connection the relation of the heart load to blood-pressure has received considerable attention under the title of *GIBSON'S RULE.*

"When the systolic pressure expressed in millimeters of mercury does not fall below the pulse expressed in beats per minute, the fact may be taken as an excellent augury, while the converse is equally true, i. e.: when the pulse rate per minute is higher than the pressure of the millimeters of mercury, the equilibrium of the circulation is seriously disturbed."

Fraenkel (25), quoted by Janeway, finds a subnormal pressure the rule, especially at the time of the crisis. In one third of his cases, however, it was absent.

There has been a great deal of discussion on the matter of this rule, but the general consensus of opinion to-day would seem to favor it. However, these seems to be considerable evidence to show that a too pessimistic prognosis should not be placed on a hypo-tension alone.

Gilbert and Castaigne (26) put forth that in favorable cases the tension never decreases materially. There seems to be considerable diurnal variation, which should prevent us from drawing conclusions on a single reading.

Scarlet Fever, Diphtheria, Measles and Rheumatism—All acute infectious diseases, excepting Meningitis, and possibly Nephritis, are accompanied by low blood-pressure. A renal involvement

may serve to raise the blood-pressure slightly. High blood-pressure in any infectious disease should lead to a careful elimination of Meningitis and Nephritis, before committing ourselves to a diagnosis.

Syphilis—The blood-pressure in syphilis varies according to the stage of the disease and the anatomical site of the lesions. During the chancre, or primary period the blood-pressure is low. During the secondary and tertiary stages, the latter particularly, there is an arterial involvement which usually means hyper-tension.

Syphilis has a predilection for the aorta and a high pulse pressure in known syphilitics would lead us to suspect an aortic regurgitation.

Glandular Extracts—Although Falta, Schaefer and Sajous have done a great deal in the science of endocrinology, we are yet only able to apply clinically a few preparations of the internal secretions and this largely on an empirical basis. It would seem, however, that some day our therapeutic armamentarium will receive many reinforcements from this source.

With the exception of adrenalin extracts and preparations of the hypophesis cerebri, posterior lobe, the intravenous injection of glandular preparations causes a lowering of the blood-pressure.

Altitude—Altitude causes a slight fall in pressure in the normal individual. Acclimation brings the pressure back to normal. The susceptibility of individuals differs widely. A given amount of exercise in a high altitude produces a higher arterial tension than the same amount at a lower altitude in an untrained man.

Epilepsy—Between seizures the vascular tension shows very little change. During the seizures there is a rise due to muscular contraction; following this there is considerable fall for some time.

Arteriosclerosis—Arteriosclerosis is again mentioned at this point to emphasize the occasional existence of low blood-pressure. Especially in the generalized or defused type there is usually a low blood-pressure. These cases show myocardial change, such as brown atrophy and some connective tissue formation.

The probabilities are that a refined technique will show thickened arteries in a number of patients with decreased vascular stress. Fisk (15) speaking in this connection advises the following method: "The circulation in the radial, or other artery that is being palpated, is cut off by pressure of the index and ring fingers. The middle finger then carefully explores the artery, pressing it firmly down on the bone and noting whether the artery may still be felt either as a ribbonlike band, a thick tape, or a hard tube, depending on the degree of thickening.

SUMMARY

Summarizing our knowledge of low blood-pressure we may safely state that all acute infectious diseases are accompanied by a low blood-pressure excepting acute Meningitis, and possibly Nephritis. The increased intracranial tension here being responsible for a rise in blood-pressure.

The injection of glandular extracts, except adrenalin and pituitin will decrease the blood-

pressure. With negative clinical findings a low blood-pressure would lead us to suspect tuberculosis.

CHAPTER IV

DISEASES IN WHICH BLOOD PRESSURE IS NOT DEFINITELY KNOWN

There is a certain class of diseases which, while they are usually accompanied by alterations in the blood-pressure, seem to have no constant effect on the vascular regulating mechanisms. One observer will report one change while another will be at variance, or we may even find a great difference in individual experience. Recent investigation with improved instruments have taken many diseases from their classic categories in this respect and thrown them into an entirely different group.

EXOGENOUS INTOXICATIONS

Plumbism—Plumbism has always been considered an intoxication accompanied by a high blood-pressure, but is now believed to have nearly a normal blood pressure, or only hyper-tension during attacks of colic.

Morphinism — Some observers, Pettey (27) report high blood-pressure in morphinism. This is laid to portal congestion induced by constipation. Inasmuch as many believe constipation may be accompanied by low blood-pressure the above statements must be accepted with considerable reserve.

In these cases, however, thorough elimination

brought about a rise of blood-pressure. Results of Valenti's (28) works lead us to believe that stimulation of the circulation may be necessary at times during the withdrawal stage of the treatment of morphinism.

Tobacco—There has been much discussion as to the physiologic effect of tobacco and so far nothing very definite is known.

Cannon (29) says that blood-pressure is raised, due probably to a stimulation of the suprarenals by the sympathetic. There has also been considerable discussion as to whether the constitutional effects which follow the use of tobacco are due to nicotine or other substances.

No doubt carbon monoxid plays an important part. According to some authorities hydrocyanic acid, furfurol and other aldehydes have also to be reckoned with. Lehman (30) has shown that the slower the rate of smoking the smaller amount of hydrocyanic acid forms.

Blood-pressure is increased only partly through stimulation of the vasoconstrictor center of the medulla. It is chiefly the peripheral influence as it occurs even after extirpation of the spinal cord.

Lee (31) apparently succeeded in producing definite vascular lesions in rabbits, which were made to inhale tobacco smoke over prolonged periods of time.

The withholding of tobacco is an important point in the therapy of arterial hyper-tension, arteriosclerosis and also in heart disease.

Acromegaly—Chronic disease of the pituitary body produces a low blood-pressure, according to most observers. Some, however, have reported

cases associated with increased vascular stress. These statements are in part reconciled by Brown (32), who states that blood-pressure bears a close relation to the sugar tolerance, being low at first and high after the disease has progressed.

Addison's Disease—Vascular stress is extremely variable and capricious in Addison's Disease. It seems to have no relation to either the clinical symptoms or pathology, except possibly hypotension is most frequent with medullary involvement.

Gout—Of the blood-pressure in this disease nothing is definitely known. A consideration of its pathology would make one expect hyperarterial tension, but as the disease itself is usually masked clinically by renal or other lesions we cannot be safe in ascribing a concomitant hyper-tension.

Diabetes—There is a growing conviction with many investigators that blood sugar and urine sugar are in some ways related to vascular stress. The work of Lee and Scott (33) has shown that high humidities reduce blood-pressure and also blood-sugar, which would seem to furnish corroborative evidence of Neubauer's statement.

Status Lymphaticus—Nothing is known definitely as to the effect of thymus disease on blood-pressure. Patients in whom this complex appears are sub-normal in every way and the low arterial tension is probably simply an incident.

Obesity—So far as is known there are no specific alterations in blood-pressure accompanying obesity.

Dunin has found that a decrease in pressure

in obese patients is usually associated with a loss of weight. However, if the circulatory system is normal a loss of weight does not affect blood-pressure.

Faber (34) reports a very frequent hypertension (50% in his series.) Dyspepsia is incriminated as being a factor because of its producing an elevated pressure before there is much obesity.

Myxedema—Myxedema is quite frequently accompanied by a hyper-arterial tension.

Anemia—Blood-pressure determinations are very valuable in this disease as they may eliminate a renal factor in the production of the peculiar palor and weakness. Nephritic complication, of course, raises the pressure.

Cachexia—A cachexia from any cause such as malignancy may mask the blood-pressure findings in concomitant lesions which would otherwise show themselves in the blood-pressure findings.

Neurasthenia—In Neurasthenia, characterized by Bishop (22) as "pathologic fatigue," the blood-pressure is subject to considerable variation. In true neurasthenia, due to the exhaustion of the nerve centers, the pressure is low, while a similar symptom complex, due to circulation of toxins from the digestive tract, is accompanied by high pressure. The blood-pressure examination is of aid in differentiating the two conditions.

Dementia Praecox—Blood-pressure is nearly always low, probably due to the general subnormal condition of these patients.

CHAPTER V

THERAPEUTICS OF ABNORMAL BLOOD-PRESSURE

Introduction—Hypo-tension—Physical Therapeutics—Drug Therapy—Dietetics—Hyper-tension—Physical Therapeutics—Drugs—Diet—General Conclusion and Summary.

From a therapeutic standpoint, arterial and cardiac diseases form a unique group, insomuch that co-operation of the patient is absolutely necessary. Considering the etiology, particularly of hyper-tension, it is obvious that the patient's condition is due in a large measure to an error in his habits of living. The correction of this error is of first importance in the treatment, and without the patient's co-operation our best directed efforts must inevitably fail.

The problem is frequently rendered more difficult by the patient's firm conviction that the habits which we know to be pernicious are harmless and essential to his enjoyment and comfort. There are, of course, exceptions: now and then we find a man who has been a "high liver," arriving at the age of 40 with a badly impaired physique who is willing and even anxious to co-operate with us and go to any length to undo as much of the evil as possible. Needless to say, these cases offer an immeasurably brighter prospect, from the standpoint of prognosis, other things being equal, than the great majority with which we have to deal.

PHYSICAL THERAPEUTICS— HYPO-TENSION

The application of the measures of physical therapy to the relief of hypo-tension is usually productive of much good, although they do not occupy the high place that they do in hypertension. We are oft trying to combat a constitutional make-up and not an acquired condition, as we find in increased arterial tension.

Rest—Rest is a great therapeutic dissideratum; that is, temper the patient's exertion to the nourishment available. Especially in those cases who are mentally overworked, a lightening of the burden and prescribed periods of rest, say eight hours at night and one or two hours daily (after the noon meal), will frequently give a marked improvement.

Exercise—A certain amount of exercise, preferably taken outdoors, is also necessary, but it should not be prolonged or of the competitive type. The patient should be cautioned against overdoing in the matter of exercise and should stop upon becoming slightly fatigued (see under blood pressure in athletics).

Hydrotherapy—Cool baths (75° F.) raise blood-pressure and are indicated in practically all cases of hypo-tension. They should be used with considerable discretion, as increased peripheral resistance may throw such a burden on an already weak heart that syncope might ensue. There is no doubt, however, of their value in the majority of cases of hypo-tension. A cool plunge may be beneficial, taken on rising.

Spray Baths—It is to be remembered that the great benefit of cool baths is derived largely from the friction applied to the surface of the skin after the bath. This may be accomplished by simply rubbing, or better still by the needle bath in which numberless fine streams of water are allowed to play on the body. Another common method is to force the water through the hollow projections of the rubber brush used for this purpose.

Carbonated Brine Baths—Carbonated Brine Baths do good in hypo-tension because of their cardiovascular tonic effect. Their action is comparable to digitalis.

DRUG THERAPY

Tonics take first place among drugs in the treatment of low blood-pressure.

The classic mixtures of iron, quinine and strychnin should be administered three times a day, before meals.

Potassium Iodid gives a benign effect in the luetic conditions, congential and acquired.

Epinephrin—Epinephrin is administered per mouth, intravenously, intraspinally and hypodermatically. The therapeutic indications of the drug and the methods of administration are not yet well worked out. Its best use is in combating decreased vasomotor tone where we have a reliaable heart. In fiive to ten minim doses, one to twenty-five thousand dilution, as saline infusion, it is indicated in shock and collapse during anesthesia.

Ammonium—Ammonium Carbonate or Aro-

matic Spirits is a good cardiac stimulant, but its effects are very fleeting.

Pituitary Extracts—The action of pituitary gland extracts is to increase ventricular contraction and slow the pulse and increase peripheral resistance. These effects are longer than those due to adrenal extract.

Strychnin—There is much discussion on the pharmocology of strychnin. The classic intoxications are vasomotor depresssion of central origin. Recently massive doses have been exhibited with certain favorable effect.

DIETETICS

Diet requires attention in hypo-tension as well as in hyper-tension.

One of the first considerations after elimination in the treatment of essential hypo-tension is the selection of a nourishing, non-constipating, anti-putrefactive diet. A depressor body has been isolated from the intestinal mucosa. This fact emphasizes the necessity of maintaining, as far as possible, bowel asepsis.

HYPER-TENSION

Before treatment is begun the physician should thoroughly inform himself as to the diet and other habits of the individual, particular attention being given to the history of acute diseases, or infections, over indulgence in food, venery, alcohol, tobacco, coffee, tea, recreation, business and domestic worries.

The habits as regards the kind and quantity of food ingested and the time and manner of taking

will be shown by a carefully obtained history and a twenty-four-hour record.

The urine should also be collected during this period and a complete chemical and microscopical examination of a mixed twenty-four-hour specimen made.

Hyper function in the adrenals with a lessening of thyroid activity not infrequently follows the acute diseases and infections of early life. Disturbances of the internal secretions should be kept in mind in the investigation of every case of hyper-tension.

PHYSICAL THERAPEUTICS

Hot Baths—recently hot baths have been employed in the treatment of vascular hyper-tension. The objection has been made that the lowering of blood-pressure occurs as a phenomenon of exhaustion after a preliminary rise. The danger period is during this preliminary rise and the patient should be carefully watched for some minutes after being immersed in hot water (105 to 110° F.) When beads of perspiration begin to appear on the forehead, the patient should be removed from the bath.

Warm Baths—Warm Baths (95 to 105° F.) are very important in the treatment of hyper-tension. They should be taken before retiring, with the water about body temperature. With a good heart a gradual vasodilatation occurs, which lowers the blood-pressure for some time and their repeated use will produce a permanent lowering.

Nauheim Baths—Nauheim Baths are indicated

in myocardial weakness. Sweating produces a lower blood-pressure, beside the good effect of elimination. It is indicated in impending uremic crises and renal involvement.

Oxygen Baths—Oxygen Baths are regarded by many observers with considerable value. Baedeker (35) says that they are contraindicated in anemia.

Rest—A part of the symptoms of high blood-pressure are met by rest applied as a therapeutic procedure. Grossman (11) treats high blood-pressure very successfuly with muscular relaxation. He says "with muscular relaxation for the purpose of reducing blood-pressure, we endeavor to induce a state somewhat similar to sleep, a state typefied by diminished spasm of the muscles of expression, and of winking, a state of muscular relaxation accompanied by regular effortless diaphragmatic breathing." This last should receive a great deal of emphasis, as physical rest without mental equanimity is impossible.

High-frequency Currents — D'arsonvalization has been considerably exploited as a treatment of hyper arterial tension. Some observers who are entirely competent aver that any good effect from high-frequency currents is due to its thermic action. Nevertheless, they seem to exert a benign influence on certain functional cases of vascular stress with mild renal involvement.

Massage—In massage, blood-pressure is increased during the first part of the treatment but is lowered in its later stages. The greatest effect is on the elimination and the increasing of venous and lymphatic circulation. Abdominal massage

should be done by a skillful operator as, in hypertension, with much cardiac involvement, serious depression may occur. The good effect is due to the increase of intestinal peristalsis.

Radium—The data on radium is so slight at the present time that very little may be said either in favor of or against its use. The usual method is per mouth in drinking water, or by bathing in radium charged water.

Climate—Our data on climate and its relation to hyper-tension is rather meagre. It has been empirically worked out that renal cases do better in warm, dry, equitable climates, in not too high an altitude. High humidities lower blood-pressure, as is well known, but they exert so many other deleterious effects that the advisability of recomending them in the treatment of high blood-pressure would be questionable in the light of our present knowledge.

Psychic Treatment—The only phase of suggestion which would appear in connection with high blood-pressure treatment would be the morbid introspection of the patient on being informed of his condition. It is well in this class of cases to refrain from any suggestion which might give him undue concern because of his condition.

Respiratory Gymnastics — Systemic deep breathing in the open air is of value in both hypertension and hypo-tension. As to just what the changes induced are: physical, the volume of air change, blood flow and lymph circulation; chemical, changes in the respired air and blood,—we do not exactly know, but on the basis of elimination alone they will be indicated.

DRUG THERAPY

While the range of drug therapy in increased vascular stress is not so great as it was once believed to be, there are still certain drugs which meet well known indications and behave very consistently.

Aconite—The use of Aconite in hyper-tension is extremely limited. It produces its effects by weakening of the myocardial contraction. da-Costa (36) found it of value in acutely strained hearts when used in combination with digitalis. Hirschfelder (1) affirms its value in post febrile tachycardia.

Alkali—Alkali may serve to raise the alkaline index of the blood, thus neutralizing to a certain extent some of the products of bacterial putrefaction in the intestines.

Pilocarpine—Robinson (37) highly recommends pilocarpine in small doses gr. 1/30 t. i. d. in water. It is a very active diaphoretic.

We must remember that Busquet (38), quoted by Hart, has succeeded in producing experimentally an auricular fibrillation with pilocarpine.

Thyroid Extract—It is chiefly indicated in women, after the menapause, suffering from nervous derangements due to the cessation of the ovarine secretion and accompanied with hyper secreting adrenals. Its depressor properties are probably due to cholin.

Belladonna—Atropin is sometimes of value in pulmonary edema.

Caffein—Coffee is of value in collapse, the hot infusion being thrown into the rectum acts as a

temporary stimulant, causing a slight rise in blood-pressure. It also increases the secretion of urine.

Camphor—Camphor in sterile oil may be injected hypodermically in shock. It usually produces a transient increase in the pulse rate, and is a fairly good cardiac stimulant.

Iodids—Iodids are one of our most valuable drugs in the treatment of arteriosclerosis. The physiological effect is not definitely known. Empirically, however, their place is assured and they are indicated in practically all the late stages.

Viscum Album — (Mistletoe) — Mistletoe is mentioned by R. Gaulthier (39) and is used for the purpose of lowering blood-pressure. It is given in doses of about one-half drachm.

Digitalis—Digitalis is our sheet anchor in myocardial lesions. It slows and strengthens the heart and is indicated in hypo-tension, due to a cardiac decompensation, or a weakening of the myocardium from any cause. It also aids in the nourishment of the cardiac musculature. A high pressure stasis may sometimes be relieved by the judicious use of digitalis. In emergencies, suitable preparations of digitalis may be injected hypodermatically or intravenously.

DIET

No case of hyper-tension should be treated without careful attention to diet. If possible the diet should be figured on a caloric basis. The first requirement of the diet should be that it is non-putrefactive. The protein foods such as meats, eggs, fish, milk, cheese, beans and peas should be

entirely eliminated during the early part of the treatment and allowed only in small quantities in the later stages.

When the patient is first seen in an advanced stage complete starvation for several days is a very useful measure. This should be combined with the rest treatment.

If kidney irritation is prominent the Karell diet—a glass of milk at 8-12-4 and 8, throughout the day—will be of service. When a more complete diet can be resumed, fruits should be eaten at each meal and when obtainable, green vegetables. At all times, however, fried foods, as well as pastries, hot breads, cakes, richly seasoned foods, tea, coffee, alcohol and tobacco should be forbidden.

In patients with good strong hearts and where the symptom complex seems to point largely to circulatory irritants, the liquid intake may be increased ad libitum. With an unreliable heart and organic hyper-tension, liquid should be limited, and taken by sipping on an empty stomach.

GENERAL CONCLUSION AND SUMMARY

Summary—Every patient is a law unto himself and should be individually studied. His cooperation should be secured and he should be instructed that *moderation* be his watchward of living. A judicious combination of warm baths, rest, massage, corrected diet and possibly high-frequency current, if applied in the proper mental attitude, of both physician and patient, will in most cases bring favorable results. Drugs given

on specific indication are helpful. It is well to remember in this connection that "moderation" is a good word for the doctor.

CHAPTER VI

BLOOD-PRESSURE IN LIFE INSURANCE AND A CONSIDERATION OF THE TESTS FOR CARDIAC EFFICIENCY

Present Status of Blood-Pressure Readings—Fisher's Tables—Method of Conducting Examinations—Tests for Cardiac Efficiency.

Statistics collected in the past several years since blood-pressure determinations became essential in life insurance examinations show conclusively the vital relation between longevity and arterial pressure variations. As our instruments and technique have improved, the value of the sphygmomanometric determination has been enhanced, and it stands to-day at the very top of the list of our means of ascertaining an individual's actuarial classification.

FISHER'S TABLES

(See page 55)

The painstaking and exhaustive investigations of J. W. Fisher, M. D., Medical Director of the Northwestern Mutual Life Insurance Company, have added a great deal to the knowledge of the value of blood-pressure readings in life insurance. In his latest work (40) he tabulates the record of 2,630 accepted risks, ages forty to sixty, and having an average systolic pressure of 142 mm. The mortality in this class was 93.16 per cent. In 521 accepted risks of the same ages, having an average of 152.6 mm. systolic pressure, the mortality

Summary of the Mortality Experience of the N.W. Mut. Life Ins. Co., with respect to Systolic Blood Pressure.

Period.		No. Risks. Acc'd.	No. Risks. Rej'd.	Ages. (Inc.)	B.P. Mm. Hg. Range	B.P. Mm. Hg. Av.	Other Imp't.	Mortality to Aug 1st 1915. M.A. Table. 100% 200% 300%	%
Aug. 1st 1907 to Aug. 1st 1910		2630		40-60	140-149	142	—		93 16
		521		40-60	150-160	152 6/8	—		127 00
			302	40-60		170	None.		250 41
			288	40-60		171	One or more.		302 16
Aug. 1st 1907 to Aug. 1st 1915			1274	40-60		160	None.		220 11
			956	40-60		165	One or more.		263 76
Nov. 1911 Aug. 1915			495	16-39		150	None.		142 61
Low B.P.	1907-1910 (Inc.)	200		40-60	105 & under		—		47 00
		427		40-60	106-110		—		65 00
	Nov. 1911 to Aug. 1915.	433		16-39	100 & under.		—	2 deaths.	
		60		40-60			—	No deaths.	

jumped to 127 per cent., while in 302 rejected risks, ages the same, and having an average systolic pressure of 170 mm. with no other impairment, the mortality soared to 250.41 per cent. Dr. Fisher summarizes the mortality experience of his Company with respect to the systolic blood pressure in a descriptive chart (See page 55) and forms the following conclusions from his study of the subject:

I. That a persistently high arterial tension will result in an excessive mortality, and the higher the arterial tension the greater the mortality.

II. That a persistent systolic blood pressure of about 12 mm. above the average for the age would seem to indicate the limit of normal excess variation in man.

III. That an apparently healthy person may have high arterial tension extending over a considerable period of time without a discoverable impairment to account for same.

IV. That of the medical impairments found, together with high arterial tension, both below and above the age of 40, more than 75 per cent. are cardiovascular.

V. That while the normal average blood pressure increases with age so far as investigated (i. e., age 60 or 65), materially higher arterial tension is not necessarily to be expected at older ages.

VI. That persons with a systolic blood-pressure between 90 and 110 mm. show a more favorable mortality than persons with a pressure of 12 mm. above the average pressure for the age.

VII. That in persons whose weight is 20 per cent. or more in excess of the average for height and age, blood pressure averages about 4 mm. higher than those of normal weight.

METHOD OF CONDUCTING EXAMINATIONS

As was shown in a previous chapter, excitement, exercise, position, digestion, etc., influence blood-pressure to a marked degree, and as these factors are simply incidents in the life of the individual, the blood-pressure taken while being acted upon by their influence would not give us an index of the natural organic vascular level of the patient. Our report is but a flashlight on the physiology of the applicant, at best, and this picture must be taken during the normal natural quiescent period of the applicant's existence.

The vascular tree is an organization in which the essential element is the ability to alter its shape almost instantly in response to small stimuli originating in any part of the body. In answer to the vicissitudes of the day it is continually quivering and varying in every branch. Adopting this view of the circulation it is obvious that the success of our attempts at taking blood-pressure depends largely upon our method of approaching the patient and treating him during the preliminary stages of the test. Thus a patient coming hurriedly into our office, removing his outer garments with considerable flourish and briskly pulling up a tight-fitting undershirt sleeve, will give us a picture of the amount of change which his arterial system is capable of undergoing, in response to a comparatively small stimulus, but

his blood-pressure reading so obtained will be unreliable. These cases should be handled in a quiet, calm and reassuring manner and cautioned against unnecessary exertion and excitement.

In the case of timid, shrinking, frightened individuals they should be assured of the painlessness of the proceedings, and in every way at our command, we should endeavor to put them at their ease. Other things being equal, the actual taking of the blood-pressure should not be done immediately on the patient's entrance, but only after a sufficient time has elapsed to allow these emotional states to subside.

Another item which should receive careful attention, if we wish to insure accuracy in our insurance examinations, is the time of day, in relation to the patient's habits, at which the examination is made. The examination should not be made when the applicant is fatigued, at the end of a hard day's work, nor immediately following a heavy meal. If the applicant is laboring under considerable mental stress from financial reverses, domestic trouble, or other causes of physiological hyper-tension this part of the insurance examination had better be deferred until another time.

Position—The effect of posture upon blood-pressure is not as yet definitely known, but whatever its influence may be it can be counteracted by always having the patient in the same position. Perhaps the best attitude is gained by seating the patient comfortably in a chair with the arm resting on a table at about the level of the heart.

Application of the Sleeve—While placing the sleeve on the arm the patient should be assured

of the complete harmlessness of the test and it is well to gently inflate the sleeve for a few seconds, then release the pressure to accustom him to the somewhat unpleasant feeling of arm compression. The pulse rate may be counted at this time as both the blood-pressure and pulse readings should be taken under the same conditions.

The auscultatory technique explained in Chapter I. should be followed.

The actual work of taking the blood-pressure need consume at the outside only about two minutes. With an experienced worker it should be done in a fraction of a minute. The examiner's mind should be concentrated on the work and the technique carried out as rapidly as possible.

We can do a great deal to reassure the patient by removing the bulb from the tube of the compression bag immediately after the reading is taken. This insures a rapid and complete emptying of the bag, allowing the circulation in the arm to resume its normal state in a very short space of time and the disagreeable sensation of compression of the arm is soon relieved. The more we do to overcome the patient's fears in the first examination, the easier and more accurate will be our subsequent examinations.

A word should be added in regard to the equipment of the physician's office for insurance examinations. Very few articles are required, but these should always be on hand and in proper working order. The most essential are—a good microscope, sphygmomanometer, an accurate, well designed urinometer, together with the necessary apparatus and reagents for the estimation of indican,

sugar and albumen, a pair of scales and a measuring rod for height, etc. Inasmuch as all insurance examinations should be made with the patient at least partly disrobed, the maintenance of comfortable temperature should receive careful attention. A low couch, aside from the usual examining chair, completes the equipment.

Summarizing—Immediately on the patient's entrance to our office we should request him to remove his coat and waistcoat, and in a quiet reassuring manner seat him comfortably and begin our preliminary questioning. The room should be warm and well lighted and all our apparatus conveniently at hand.

Both systolic and diastolic pressures should be routinely estimated and reported. While it is true that the diastolic pressure in the past has not been required by many of the companies, those requiring it are constantly increasing and there is but little doubt that the next few years will see it in general demand.

FUNCTIONAL TESTS FOR CARDIAC EFFICIENCY

While in life insurance examinations we wish to have the individual at complete rest, when we wish to know something of the capacity of the heart to respond to functional demands, we must examine the individual immediately after a period of physical exercise, or after the heart has been subjected to some unusual stress.

A number of tests have been proposed, utilizing various methods of temporarily increasing the burden of the heart. From experiment we

know that a normal heart should respond to an increased demand with certain characteristic changes in rate and output and its functional efficiency is determined by any or all of these manifestations.

An efficient test, modified after Graupner's (41) is as follows: The pressure sleeve is snugly applied to the bare left arm and during the active part of the following procedure the bulb and instrument may be carried by the patient, the left arm being held well up, to prevent the cuff from slipping down and causing any after delay in determining the pressure.

First—The diastolic, systolic and pulse pressures and the pulse rate are carefully taken with the patient in a sitting position, care being taken to see that the patient is at ease, with muscles fully relaxed. The color of the skin, the circulatory and respiratory conditions are carefully noted. A record is made of these findings.

Second—The patient is now put up one or two flights of average stairs at a reasonable speed, or subjected to a series of bending or high stepping movements, and the pressure is determined immediately thereafter. No time should be lost in determining the pressures following this exercise, since in some instances the systolic pressure may drop as much as 15 mm. or more in one minute.

Third—The patient should now be comfortably seated with the arm supported on a table and entirely relaxed for five minutes. During this interval the pressure should be determined every two minutes.

Normally both systolic and pulse pressures and

pulse rate show an increase after the exercise, with a return to normal after the period of rest. The diastolic pressure usually falls a few millimeters, but may show a slight rise or remain unchanged.

A change in the systolic and pulse pressures, immediately or after a transitory rise, and a delay of their return to normal, indicates myocardial weakness.

A lowered pulse pressure, associated with a marked increase in pulse rate, is a definite sign of impaired efficiency.

Katzenstein's Method (42)—The exclusion of an amount of blood from the circulation (by constricting of the thigh) alter the heart beat and affect pressure perceptibly. We make use of it in the treatment of angina pectoris, where it lowers (sometimes elevates) pressure and usually slows the pulse rate.

The Katzenstein method of testing the function of the heart is based on the observation that on digital compression of both femorals blood-pressure of the healthy will rise from 10 to 20 mm., while the pulse rate remains the same. In a weak heart, however, the pressure remains on the same level, or is lowered, while the pulse rate is apt to increase. Also the absorption of very large amounts of water (intravenous infusion, excessive drinking) lowers blood pressure normally—Richter (7).

Crampton's Test (43)—Crampton's test of vasomotor efficiency. This test rests on the response of the heart to changes of posture. Inasmuch as there is a great deal of uncertainty

regarding the effect of posture, the usefulness of this test is perhaps very slight.

The patient should be placed in a horizontal position and the heart observed until the rate becomes regular after several minutes. He is then allowed to stand and the heart rate again counted until it becomes uniform after several periods. The difference in rate and pulse pressure are calculated and reference is made to a scale. This method has the advantage of being able to give a numerical value to a functional, cardiac and vasomotor condition.

Cardiac Aptitude—Lian (44) has devised a method of judging the heart condition by its rate before and after short periods of exercise. Ascertain the normal standing pulse rate by having the patient flex the legs on the thighs (a high stepping action) to a right angle, for five minutes, a rhythm of two per second being maintained. At the close of the five second period, with the patient in an erect position, the pulse is again counted and at intervals of forty-five seconds thereafter until the pulse attains the rate manifested before exercising. If this occurs by the second minute he is rated as 100. If the pulse is still high at the fifth minute that patient is pronounced a bad risk.

Cautions.—For obtaining the record of advanced cases unable to go through the exercises as above outlined, a few bending movements, or the variation of pressure noted in changing from the reclining to the sitting or standing position, may be used.

Cyanosis or dyspneoa appearing during or after the exercise is definite evidence of impair-

ment and where they are marked and appear early in the exercise the tests should be discontinued or proceeded with very cautiously.

As the value of the tests rests largely on knowing the circulatory conditions immediately after the exercises, it is very essential that the physician have a high degree of proficiency in technique, otherwise a significant change may pass unnoticed.

To avoid delaying the readings, the pressure sleeve should be snugly applied, so that it will not slip down, and the patient should carry the instrument so as to disturb its position as little as possible.

Accurate results are possible only by the use of the auscultatory method.

In athletes, or those who have accustomed themselves to strenuous forms of exercise, the greatest exercise to which they are accustomed should be employed. The above movements are applicable to the large number of individuals of moderately active habits and occupation.

The mercurial type of instrument is entirely inadequate for this use, as the readings must be taken immediately after the exercises. In the case of the diaphragm instrument the bulb and dial may be worn during the test, and the readings may be made almost co-incidently with the cessation of the exercises.

Blood-pressure in Athletics—Any individual before engaging in the pursuit of the more strenuous forms of competitive athletics, as Equestrian Polo, Rugby, Marathon Racing, etc., should undergo a thorough physical examination, especial

emphasis being laid on the heart and vasomotor efficiency.

No man with even the slightest impairment of the heart, as manifested by cyanosis, undue increase in the heart load, or respiratory embarrassment after any of the functional tests, should be allowed to engage in the athletic exercises above mentioned. In the present state of our knowledge on the subject we would especially caution against passing individuals who show a marked systolic rise after exertion.

CHAPTER VII

BLOOD-PRESSURE IN OPHTHALMOLOGY

Visibility of the Artery in the Eye—Importance of the Sphygmomanometer—Prognosis of Arteriosclerosis—Ophthalmoscope and Sphygmomanometer—Changes in the Eye in Arteriosclerosis—Diarrhoea—Anemia—Diabetes—Syphilis.

The only organ of the body which is transparent is the eye. The blood vessels of its interior are thus easily inspected and we are able to follow definitely minute changes in the arterial system by watching the retinal arteries. It was long known that certain retinal changes accompanied arterial disease, but that this complex was foreshadowed and in a measure due to increased blood-pressure has only recently been discovered.

Perhaps in the entire domain of medicine there is no field in which the sphygmomanometer is of such paramount importance as in Ophthalmology. The eye is so frequently the first sufferer in systemic disease, and such a continuous sufferer, that unless the systemic derangement is alleviated it behooves those engaged in eye work to acquaint themselves with the general pathology of the patient.

Preventive measures are vastly more important and more efficient than corrective ones. In the majority of cases it is easier to prevent the destruction of tissue than it is to repair it after destruction has taken place. The latter may even be impossible.

Every case of rising blood-pressure is potentially capable of producing the classic eye symptoms of arteriosclerosis. The first symptoms may be refractive errors, or other slight changes before the patient is aware of his systemic condition.

To a certain extent the prognosis of arteriosclerosis depends on how early treatment is begun. The oculist, due to his peculiar position, may recognize these conditions in their incipiency if the practice of routine blood-pressure reading is made, and thus do much in combating the great group of degenerative diseases.

We can safely say that without treatment no case of high blood-pressure will improve. It is not an acute infection which must run its course, but a slow insidious process which grows worse with time. In its incipient state, however, it is fairly amenable to treatment.

It is quite true that a diagnosis of arteriosclerosis as shown above can be made by the ophthalmoscope, but once the disease has progressed to a point where we have a gross retinal lesion, a great deal of arterial damage has been done, and we are already handicapped in the race, while the sphygmomanometer will detect the condition before irreparable damage has been done.

The ophthalmoscope and sphygmomanometer go hand in hand; one confirms and supplements the other. Routine blood-pressure determinations on every patient are of the utmost importance. In as much as the blood-pressure findings may influence the prescription to a marked degree the information should be obtained at first

hand by the oculist himself at the first examination of the patient.

Some ophthalmologists complain that the added burden of blood-pressure determinations makes such a demand on their time that the work must be done by someone else. In view of the extreme simplicity of the procedure with the modern apparatus, the very small amount of time required (30 seconds) and the great importance of the information gained it seems almost unthinkable that it should be done by anyone save the oculist himself. Hoover (45) speaking in this connection says: "I always prefer to take the blood pressure myself in my office than to have it taken by someone else, no matter what report may have been rendered me by the attending physician (if one was in attendance prior to my seeing the case). I have come to look upon my instrument as a necessary adjunct to my office equipment. Time in taking these readings should not be considered."

To acquaint the physician with the ophthalmoscopic picture seen in arteriosclerosis, the following is inserted. Depending on the severity and stage of the disease the following changes in the retina may be observed:

1—Alterations in the course and caliber of the retinal arteries manifesting themselves as: (a) undue tortuosity, which is not sufficient unless it is associated with other evidence of disease; (b) alterations in the size and breadth of the retinal arteries, presenting as it were, a beaded appearance.

2—Alterations in the reflections from, and the

translucency of, the walls of the retinal artery manifesting themselves (a) in increased distinctness of the central light streak on the retinal vessels and an unusual light color of the entire breadth of the artery; (b) loss of translucency, so that it is impossible to see through the artery and underlying vein at the point of crossing, as is possible in the normal state; (c) positive changes in the arterial walls, consisting of whitish stripes, indicating degeneration of the walls or infiltration of the perivascular lymph-sheaths (perivasculitis).

3—Alterations in the course and caliber of the veins, together with signs of mechanical pressure, manifesting themselves (a) in undue tortuosity, which, as in the case of the arteries is not significant except in the presence of other disease. (b) alternate contractions and dilatations; (c) an impeded venous circulation where a diseased artery crosses it. The last is a sign of the utmost importance. Ordinarily as an artery crosses the vein, as it may be seen by an examination of the normal eye ground, there is no sign of pressure, and the translucent artery permits a view of the vein beneath it. If the walls of the artery are thickened by disease, then it presses upon the vein, pushes it aside or directly contracts its caliber, so that beyond the point of crossing there is an ampulliform dilatation; (d) changes in the whitish stripes border the vessel and are indications of degeneration in its walls. Often, associated with this, one may see varicosities.

4—Edema of the retina, manifesting itself as a grayish opacity, which may be present in the

immediate neighborhood of the papilla, or in spots over the eye ground and along the course of the vessels, looking like a fine gray haze, or in little fluffy islands far out in the periphery.

5—Hemorrhages, manifesting themselves as linear extravasations along the course of the vessels, roundish infiltrations scattered over the fundus, or sometimes in a droplike form.

The above changes might be said to be the result of an undiscovered or untreated systemic condition. It is entirely tenable that these eye ground phenomena could in most cases have been prevented by early diagnosis and treatment. That diagnosis rests largely on blood-pressure determination and urinary analysis.

Nephritis—Of 935 cases of kidney disease tabulated by Groenauw and Uhthoff (46) albuminuric retinitis was present in 209, or 22.4 per cent. The small contracted kidney is the most frequent form found with retinitis. Chronic diffuse parenchymatous nephritis is the next most frequent. Nephritis of Scarletina is last.

Porter (47) concludes that the eye disease does not depend so much on the existence of the renal affectation as on the fact that the vessels are diseased.

Hyper-tension is not the only systemic condition manifesting itself in ocular changes. Many other conditions also may affect the eye; as diarrhoea, anemia, various stages of syphilis and other conditions producing low blood-pressure.

Anemia—Anemia exercises great influence in eye work. Anemia is, of course, accompanied by hypo-tension.

Knies (48) states that it is only in advanced cases that the papilla is notably paler, but says that it may even be chalky white, the blood stream lighter, and pulsations of the vessels occasionally visible. He also mentions that a rather striking fact is the great frequency of congestion of the conjunctiva, also called dry catarrh, in anemia of all kinds. One of its main causes is probably insufficient sleep, or insomnia.

Diabetes Mellitus—"The effects of diabetes consist objectively of pareses of the ocular muscles, iritis, cataract, failure of accommodation, refractive changes, retinitis, (simple hemorrhagic and punctate), optic neuritis, vitreous opacities, detachment of the retina (due to hemorrhage probably) ulcer of the cornea, retinal arteriosclerosis, etc."

As blood-pressure in diabetes, particularly in the early stages, is normal a test is largely a negative one differentiating between albuminuric retinitis and diabetes.

Syphilis—Ophthalmology gives syphilis first place among the causes of disseminated chloriditis. Syphilis also plays a large part in the production of very many other ocular conditions, varying from paralysis of the third nerves to retro-bulbar neuritis.

CHAPTER VIII

BLOOD-PRESSURE IN OBSTETRICS AND SURGERY

Introduction—The Therapy of Blood-Pressure Anomalies in Pregnancy—Surgery—Blood-Pressure in Some Surgical Procedures.

It is fortunate for the obstetrician that some of the most dreaded sequelae of pregnancy manifest themselves by changes in blood-pressure while they are yet in the incipient stage and respond with comparative ease to treatment. This makes it imperative that the blood-pressure readings be taken every few weeks during the early months of pregnancy and at shorter intervals during the later stages, as an impending eclampsia may be recognized by the blood-pressure reading, before the urine shows albumin.

Blood-pressure in normal pregnancy rarely rises above 125 mm. In young women under thirty who are normal, it will be nearer 120 mm. After normal labor, subsidence of the uterus gives a slight fall. The loss of considerable blood will entail a greater drop in the blood-pressure.

A tendency of the blood-pressure to rise should be looked upon with suspicion, even though no arbitrary point of hyper-tension is reached.

According to Hirst (49) an increase of arterial tension, particularly in the latter months of pregnancy, most infallibly points to some toxemia. Therefore, our chief reliance should be placed on the sphygmomanometer.

Hypo-tension—Hypo-tension in a patient during pregnancy is deserving of considerably less attention than hyper-tension.

In dealing with persistently low vascular stress it may in many cases indicate tuberculosis complicated with pregnancy. If the patient be supported with tonics and good food, pregnancy may run its course and normal labor ensue. It is to be remembered that in such event there may result a heavily handicapped child and a mother whose chance of future health and happiness are severely compromised.

A hypo-tension discovered during pregnancy, dependent on myocardial lesions, or a badly compensated vascular lesion, would raise the question —Can this heart stand the strain of gestation and labor?

THE THERAPY OF BLOOD-PRESSURE ANOMALIES IN PREGNANCY

The development of hyper-tension in pregnancy accompanied by dizziness, headache, insomnia and albuminuria should lead us to active therapeutic measures. Our first efforts should be directed toward elimination. This is secured by guarded catharsis, hot packs, venesection and intravenous saline infusions. A great many practitioners recommend the use of veratrum viride. The performance of abortion, or premature labor, may be necessary in some cases.

SURGERY

While blood-pressure determinations do not occupy the place in surgery that they do in internal medicine, further research shows that the rela-

tion between blood-pressure and surgical conditions are virtually associated, and to-day every progressive surgeon recognizes their increasing importance.

Anesthesia—Our best index of the response of the vital functions of the organism to the unnatural demands made upon it during anesthesia is the behavior of the blood-pressure. The administration of general anesthesia is always a potentially fatal procedure and it is our duty to make use of every method which will enable us to recognize and forestall any condition which would tend to increase the hazard. In line with this policy a blood-pressure reading should be taken before, during and after every general anesthesia.

The great circulatory catastrophy with which we have to deal is shock. A fall of blood-pressure, even if slight, during the operation should at once put us on our guard. The two great factors in its production are hemorrhage and manipulation of the vital organs. A fall of pressure below 100 mm., together with a rising pulse rate, is an indication for immediate treatment. Shock is at hand when the pulse pressure falls to 10 or 15 mm., or when the diastolic pressure falls to, or below, 70 mm.

McKesson (50) has developed a method which he finds of great value in revealing circulatory conditions throughout anesthesia. The cuff is wrapped about the arm and the end pinned with a safety pin so that it may be retained in position, without danger of slipping, throughout the period of the operation.

The stethescope is conveniently held over the

artery, below the cuff, by means of a piece of elastic webbing about one inch wide with a suitable buckle, so that the diaphragm portion of the stethescope is fairly snug against the artery.

The tube leading to the arm piece is passed through a hole in the webbing and is of sufficient length to conveniently connect with the anesthetist. It is then possible at any time during the operation to make determinations by the auscultatory method of both the systolic and diastolic pressures. (See Fig. 6.)

His technique is as follows: "The pressure in the cuff is pumped above the systolic pressure; then as the pressure is gradually released we listen for the first clear pulse tone which occurs during exhalation. This is the expiratory systolic pressure. As the pressure in the cuff falls gradually we hear faint pulse tones during inhalation, but these are disregarded until they are of equal intensity to the one first noted in exhalation. When such a tone is heard the inspiratory systolic reading is made.

"The difference between the inspiratory and expiratory readings is the respiratory influence on systolic blood-pressure. Inspiratory and expirtory diastolic pressures are obtained in the same manner.

"Ordinarily, on inhalation, diastolic and systolic pressures are from 5 to 20 mm. lower than on exhalation. When the obstruction in the airway produces marked snoring the variations may be greater, amounting to as much as 30 mm. If the respirations are very rapid, however, respiratory variations in blood-pressure are less marked.

"During inhalation, blood is aspired into the great veins, right heart, and pulmonary arteries, from all parts of the body; the pulmonary capillaries are straightened out and dilated, allowing an increased flow of blood from the right ventricle, but delivering a decreased quantity of blood to the left auricle, so that arterial pressure falls. On exhalation, this blood-saturated lung is compressed by the air within, and the chest wall without, thus forcing an increased quantity of blood into the left heart and systemic circulation and elevating the pressure for two or three heart beats; at the same moment, the compression in the lungs has a tendency to dam back the blood from entering the thoracic cavity, and when the obstruction to respiration is marked, the result is an increased peripheral venous congestion, especially noticeable in the head and neck. If the lungs are kept inflated under considerable pressure, the pulse and diastolic pressures both fall, imperfect ventilation results, venous congestion or cyanosis immediately supervene. The pulmonary obstruction or capillary compression may cause right heart dilatation.

"From clinical observation in taking these pressures, it appears that in obese patients, in whom the airway at the base of the tongue is kept free by means of a pharyngeal tube, that the weight of the chest wall in some way obstructs exhalation, possibly by collapsing the smaller branches of the bronchial tree, and thus interfering with the pulmonary circulation, dams back the blood and produces venous congestion and cyanosis." McKesson (50).

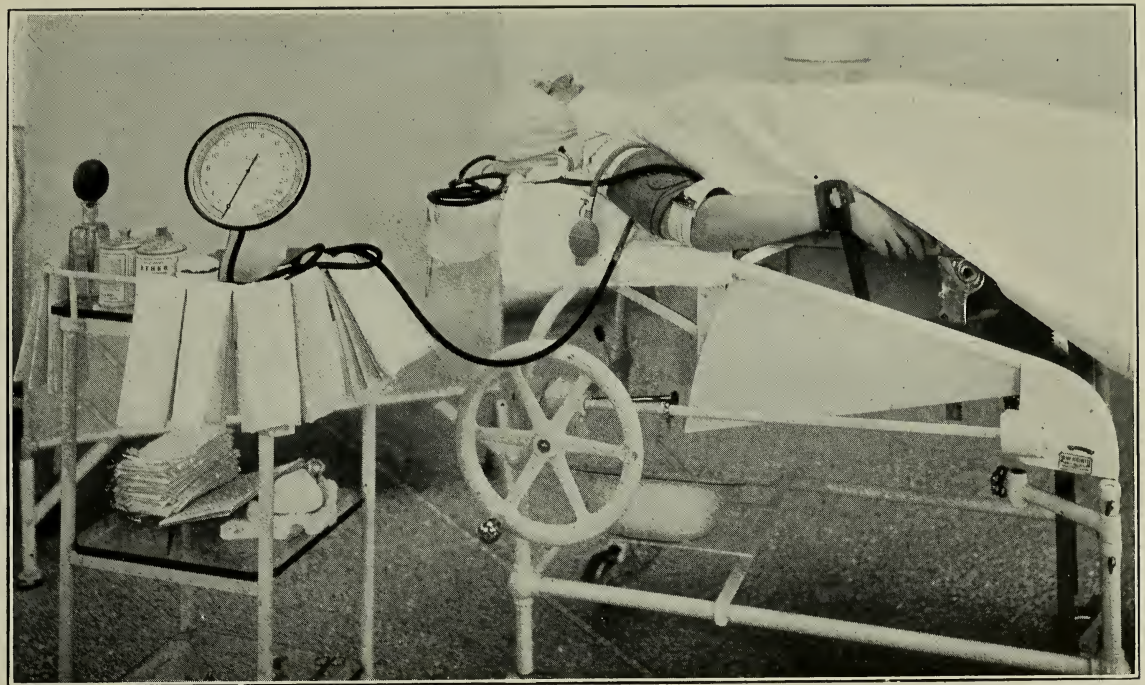


Fig. 6

Arrangement of the Office Pattern *Tycos* Sphygmomanometer as used for blood-pressure determinations during operation.

This method was originated more than five years ago by E. I. McKesson, M. D., Toledo, Ohio, and has been continuously used by him since that time.

Treatment of Shock—There is considerable discussion at the present time on the treatment of shock—Crile's Anoci Association theory has upset many of our preconceived ideas. He deprecates the use of strychnin and other so-called stimulants, and advises morphine. Intravenous injection of saline infusion is perhaps our best measure.

BLOOD-PRESSURE IN SOME SURGICAL PROCEDURES

Drainage of the Bladder — Balfour's (51) studies would seem to show that bladder drainage markedly lowers blood-pressure.

Traction of the Abdominal Viscera—Traction of the abdominal viscera produces a marked, and in many cases a dangerous fall of blood-pressure; also gauze dissection.

Manipulation of the Peritoneum—Manipulation of the peritoneum, as separation of the adhesions, etc., may cause an alarming fall of blood-pressure. This is more liable to occur during work in the upper abdomen.

Surgery of the Pelvis—There is some dispute on this question, although on the whole the vaginal route is preferable, because with the abdominal wall intact we still have the diaphragm to aid the venous flow.

Intestinal Perforation—Intestinal perforation is usually preceded by a short rise, followed by an alarming descent after puncture has occurred.

Concealed Hemorrhage—As in Ectopic Pregnancy, open rupture produces a very marked fall.

Pyelitis—Pyelitis is accompanied by a temporary hyper-tension.

Climacteric—The menapause is usually accompanied by more or less circulatory anomalies. These are responsible for the subjective symptoms of dizziness, "hot flashes," etc., so frequently referred to by women at this period of life. The pressure is usually left somewhat higher.

Spinal Anesthesia—The data at hand is very conflicting regarding blood-pressure in spinal anesthesia. There are marked fluctuations beginning with the introduction of the needle and lasting for some time. The drug effects do not seem to be consistent. The dread of the procedure usually brings a marked rise before operation.

CHAPTER IX

HEART IRREGULARITIES

Observation by the Sphygmomanometer — Sinus Arrhythmia—Premature Contraction—Heart Block—Auricular Fibrillation—Pulsus Alternans.

With the development of sphygmomanometers having an extremely short period, such as the modern diaphragm instrument, capable of giving us the picture of a single systole, it was immediately discovered that many irregularities of the heart beat were rendered easily discernible by the physician.

The doctor is here again enjoined to observe studiously the movements of the needle while making his blood pressure readings. Each excursion is a direct picture of the arterial beat and by always noting its rhythm, rate and amount of movement, many things may be learned which would be lost to palpation alone. Several methods for use in special conditions will be described later on in the chapter. To aid in the recognition of some of the more common disorders of the heart beat, as shown on the dial of the sphygmomanometer, the following brief descriptions and pulse tracings are inserted.

SINUS ARRYTHMIA

Definition—Irregularities of the heart which are produced by interferences with the rythmic impulses at the seat of their discharge.

Recognition—There are several forms of this disease, some of which are extremely rare, and will be omitted. The one most commonly met with is known as the respiratory form and will be described.

Respiratory Form: During inspiration and while the chest is expanded there is an increase in the rate of the heart. Expiration is accompanied by a decrease in the rate. These changes may be so small as to escape the palpating finger but are easily noticed by watching the movement of the hand.

Respiratory and radial curve in a case of sinus arrhythmia. The pulse rate is increased with each normal inspiration and decreased with each expiration.—Lewis (56).

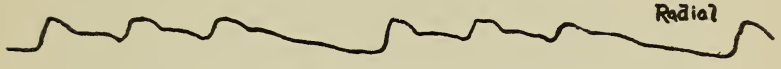
The chief value of this observation is to assure ourselves that the heart is functionating normally, in this respect. A slowing of the heart during inspiration would give us the phenomenon of pulsus paradoxus, indicating pericardial lesions.

PREMATURE CONTRACTIONS

Definition—Responses of the heart to new and isolated impulses formed in the musculature of the ventricles or auricles; contractions which occur before the anticipated time and which consequently disturb the normal order of the heart's mechanism.

Recognition—The work accomplished by premature beats is small, because the periods of rest that precede them are short. They may not even raise the aortic valves. Accompanying the premature beat a feeble pulsation or a prolonged pause is noted in the movements of the hand. By

closely watching the excursions of the needle the disturbance may be determined.



Radial curve in a case in which a premature ventricular contraction replaces each fourth beat.—Lewis (56).

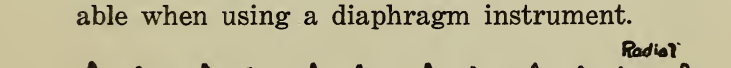
Radial tracing from a case of premature auricular contraction.
There is a "Bigeminy" or coupling of heart beats.—Lewis (56).

HEART BLOCK

Definition—An abnormal heart mechanism, in which there is a delay in, or absence of, response of the ventricle to auricular impulses.

The disorders of the heart's mechanism caused by heart block, in its several grades, are readily recognized by the exact graphic methods provided by the polygraph and galvanometer. The efficacy of these instruments and the certainty of the analysis must be evident, for heart-block produces derangement of sequence in the contractions of auricle and ventricle, and the polygraph and galvanometer supply separate records of the systoles of upper and lower chambers. Therefore, a comparison of the onsets of the several systoles is relatively simple when these recording devices are employed.

The pauses occasioned by dropped beats and the preceding increase in the rate is very noticeable when using a diaphragm instrument.

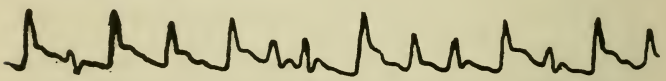


Radial tracing from a case of heart-block.
The ventricular responses fail frequently.—Lewis (56).

AURICULAR FIBRILLATION

Definition—A condition in which normal impulse formation in the auricle is replaced by stimulus production at multiple auricular foci. Coordinate contraction in the auricles is lost; the normal and regular impulses transmitted to the ventricle are absent, while rapid and haphazard impulses produced in the auricles take their place and produce gross irregularity of ventricular action.

Recognition—The movements of the needle in this condition are extremely irregular, varying in each of their three characteristics: to wit; rate, rhythm and amplitude.



Radial tracing from a case of auricular fibrillation. The heart's action is grossly irregular, but each ventricular beat reaches the wrist.—Lewis (56).

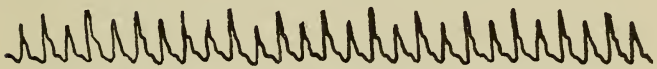
The taking of blood-pressure in auricular fibrillation. James and Hart (52) have elaborated what is termed the relative pulse deficit method. The pressure in the cuff, which has been raised above the obliteration point, is allowed to fall in successive steps of ten millimeters each and the number of waves passing through each step is checked against the heart rate. The lag in the number coming through is known as the deficit. These waves are counted until the point is reached where all come through. The average systolic pressure is determined from the following rule:

Multiply the number of radial beats by the pressure under which they come through, add their

products and divide by the number of apex beats per minute.

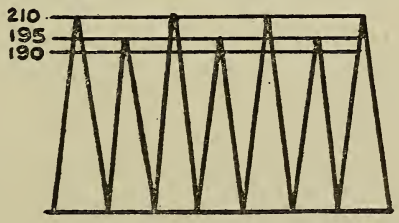
PULSUS ALTERNANS

Definition—A condition in which the left ventricle, while beating regularly, expels larger and smaller quantities of blood at alternate contractions.



Radial tracing from a case of Pulsus Alternans. Each alternate beat is strong and each alternate beat is weak.—Lewis (56).

Recognition—Herrick (4) has developed a special technique in these cases, using the sphygmomanometer. This consists in inflating the sleeve to a point where the waves of small amplitude are prevented from showing themselves by the movement of the hand, while the stronger waves are allowed to come through. It is thus seen that the pulse rate in beats per minute would be halved. By lowering the pressure in the cuff all the beats will again come through, but their disparity in size will be rendered more noticeable.



PULSUS ALTERNANS

At 210 mm. Hg. no pulse is felt at the wrist. Below 210 and above 195 the stronger beat is felt. Below 195, for example, at 100, the pulse rate doubles and the beats are alternately strong and weak.—Herrick (4).

CHAPTER X

TYPES OF SPHYGMOMANOMETERS

Introduction — Mercurial Sphygmomanometer — Diaphragm Sphygmomanometer.

To accurately measure the blood pressure, numerous kinds of sphygmomanometers have been devised. Of these only two types, the diaphragm and the mercurial, have survived.

To fulfill the exigencies met by the average practitioner in his daily work, it is essential that the sphygmomanometer possess to a high degree the qualities of accuracy, portability and durability.

Accurate determinations of blood-pressure make a peculiar demand upon the design and structural perfection of the instrument.

First—It must accurately indicate, almost coincidently with their occurrence, the rapid and minute changes of arterial pressure. Second—It must be easily portable, admitting of application to the arm of a patient while in a position difficult of access, or during movement. Third—In addition, it must be of a construction enabling it to withstand the hard usage accorded it by the average physician.

THE MERCURIAL SPHYGMOMANOMETER

The selection of mercury as an indicating medium by the early investigators was due to the fact that the metal is of liquid form at ordinary

temperatures, and because of its great specific gravity, only small quantities of the metal being required to balance the limits of systolic arterial pressure.

Prior to mercury, water was the vehicle in common use, but owing to the large volume required (water is 13½ times more bulky than mercury), a satisfactory portable instrument could not be constructed.

Mercury was fairly satisfactory so long as blood-pressure work was limited to the determination of the systolic pressure. Investigations disclosing the value of the diastolic pressure soon demonstrated the inadequacy of mercury to estimate the rapid fluctuations incident to a single cardiac cycle. The criterion of diastolic pressure being the lowest point of these fluctuations, occurring normally 72 times per minute, the inertia of mercury was found too great to accurately measure them.

This fact alone, without considering the chemical and capillary errors of the mercury column, is sufficient to condemn it as a vehicle for the purpose.

In support of this we quote: "The variations of pressure in the chambers of the heart and aorta occur so rapidly, that, as has long been recognized, the mercury manometer is incapable of following the changes accurately. This is due to the inertia of the mercury, i. e., the physical property by virtue of which it resists being set in motion when at rest, and strives to remain in motion after the acting force has ceased. This causes the apparatus to record an amplitude which does

not correspond to the pressure changes actually involved. If a high pressure is suddenly communicated to a manometer and then released, the mercury rises above and falls below the true level. The amplitude of the curves is larger than the true variation. If the variations recur rapidly, neither the highest nor the lowest pressures are approached and the recorded amplitude is less than the change which actually occurs. This is the case when the mercury manometer registers pressures within the heart and large vessels. Not only are the extremes of pressure incorrectly recorded, but the rise starts later and lags behind the pressure change. In other words, the inertia is determined by the low vibration frequency inherent in the instrument. We return, therefore, to the physical fact that an apparatus, in order to record the oscillations correctly must have an inherent frequency that is more rapid than that of the swiftest pulsations to be recorded." Wiggers: Circulation in Health and Disease (53).

Brooks and Luckhardt (54) speaking of the mercury manometer say:

"If the rate of the heart beat coincides with the period of the manometer, the oscillations are greatly augmented, but when the rate of the pulse beat is such that it clashes with the period of the manometer the oscillations of the manometer are greatly diminished, so that a given pulsatory pressure, when its rhythm is coincident with the period of the manometer, may cause oscillations of the manometer which are several times greater than the same pulsatory pressure at a rhythm

which interferes or does not coincide with the period of the manometer."

THE DIAPHRAGM SPHYGMOMANOMETER

The diaphragm dial type of sphygmomanometer satisfies the exacting demands of blood-pressure work. Its design and structure render it capable of indicating almost coincidently with their occurrence, variations of arterial pressure, making it the correct type of instrument for the purpose.

The highest development of this class of instrument possesses the unique, though absolutely essential feature of verification; that is, should the instrument receive an injury damaging its mechanism beyond a purely negligible degree, the fact is at once made known by the failure of the hand to come to rest within the zero of the scale.

Another advantage of the diaphragm feature is its portability, the pocket size of this instrument is conveniently carried about by the physician and is easily applied to the arm of his patient for blood-pressure determinations, irrespective of the position or condition of the patient, such as determinations during anesthesia, eclampsia, maniacal states, etc., and it may be left in position on the arm during the whole procedure of determining the efficiency of the circulation, no matter what the condition of the patient, or the form of exercise adopted.

This is not only important to the physician in determining the circulatory condition of his patient during treatment, but is also invaluable in all health examinations, such as life insurance,

police, firemen and in examining applicants for the army and navy.

The foregoing features which attach to the diaphragm type of instrument, together with its durability, have brought it into universal use as the most practical instrument for physicians.

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